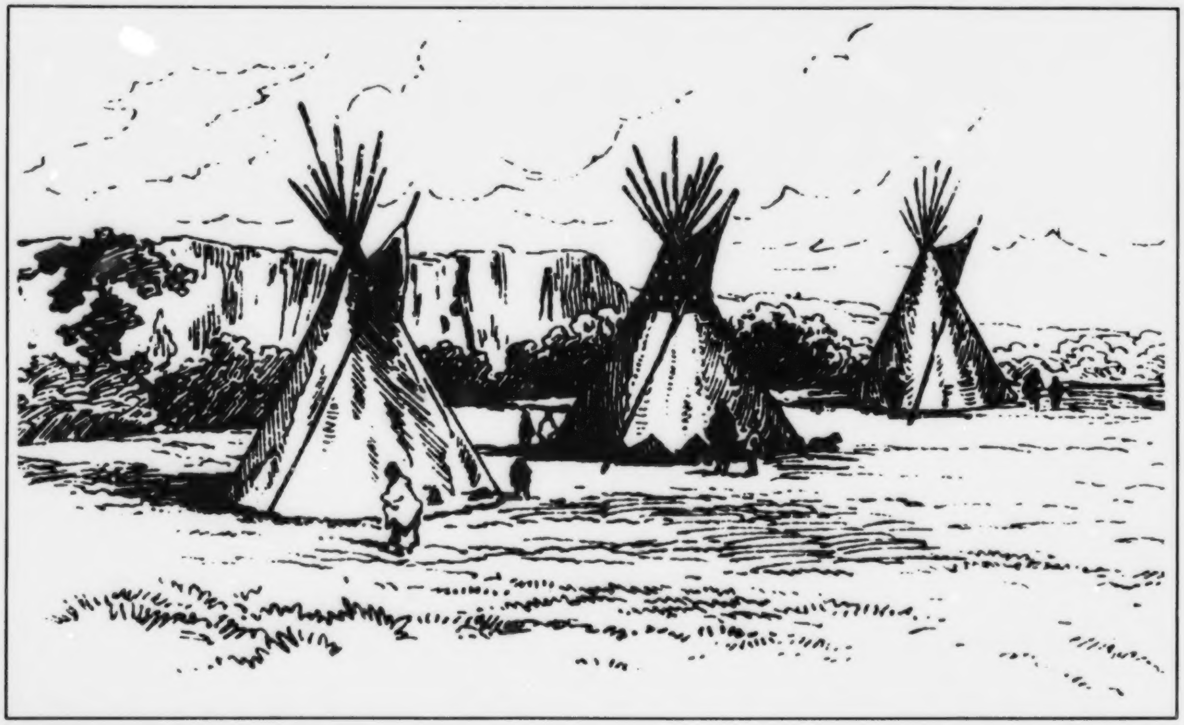
FINAL REPORT OF THE 1984 SEASON AT HEAD-SMASHED-IN BUFFALO JUMP ALBERTA

Jack Brink, Milt Wright
Bob Dawe, Doug Glaum



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CULTURE

FINAL REPORT OF THE 1984 SEASON AT HEAD-SMASHED-IN BUFFALO JUMP, ALBERTA

by

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FINAL REPORT OF THE 1984 SEASON AT HEAD-SMASHED-IN BUFFALO JUMP, ALBERTA

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ARCHAEOLOGICAL SURVEY OF ALBERTA

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March, 1986 Edmonton, Alberta

ABSTRACT

This report presents the final results of the 1984 field season at the Head-Smashed-In Buffalo Jump site (HSI) which represents the second season of archaeological research by the staff of Alberta Culture at this World Heritage Site. This multi-year research project is designed to undertake mitgative investigations preparatory to the installation of a 2400 m^2 interpretive centre and attendant facilities, as well as to conduct research oriented studies which will provide some of the information required to assemble an interpretive programme for the site. The majority of the 1984 field season was devoted to the research oriented objectives of the project which have been focussed on the poorly understood campsite deposits located on the prairie flats below the kill site deposits. Although much of the mitigative research programme was completed in the previous field season, several design modifications to parking facilities and road alignments required that further in-field archaeological investigations be conducted in 1984.

The design modifications made to the parking area put this development in conflict with a small (but significant for HSI) buried stratified site which was revealed in a 1983 shovel test programme. Excavation of several test units revealed that these stratified deposits were very ephemeral, with few artifacts and features largely restricted to the upper 20 cm of the deposit. Only one area on the northern periphery of the proposed parking area appeared destined to impact substantive archaeological deposits. It was therefore recommended that the northern boundary of the parking area be shifted to avoid impacting these deposits, and that the surface of the lot be mechanically stripped so that features could be salvage excavated. The road alignment was also mechanically stripped and features were recorded in advance of road bed construction. At the close of the 1984 field season, all mitigative programmes at HSI had been successfully completed and design modifications agreed upon prior to construction.

The research programme absorbed much of the time in 1984 and included on-site research, as well as off-site experimental programmes. In 1983, a preliminary assessment of the camp and processing site was undertaken using widely distributed test units which helped to

establish the extent and characteristics of these deposits. In 1984, it was decided that we focus our efforts on determining the variety of tasks and arrangement of activities represented in these deposits by excavating a large area of the deposits. Completion of a 7 x 8 m block excavation unit revealed a complex array of features, including a rock ring, hearths, pits and dense deposits of fire broken rock and bison bone fragments. Although these deposits are superimposed and difficult to interpret, we do feel that some insights into bison processing in the campsite are forthcoming from our analysis.

Other research programmes completed in 1984 included a preliminary investigation of bison bone taphonomy and investigation of material properties associated with the use of hearths and boiling pits. These projects are felt to be of long term assistance in addressing the analysis of bone residues and features found within the camp and processing site. The drive lane complexes were investigated in 1984 with particular attention focussed on the structure of the individual cairns and their presumed function. Our research suggests that long held assumptions pertaining to cairn morphology require careful review. Investigations were also initiated into the petroglyph sites which are found in the gathering basin above the main kill. These complex arrays of linear troughs and figures are presumed to have played some role in the use of the jump facility. A final project involved the recording of a supposed vision quest site located to the north of the HSI locality. Although it is impossible to determine if this site was used in conjunction with HSI, its investigation provides a more complete understanding of the complex archaeological record of the local area.

ACKNOWLEDGEMENTS

Many individuals contributed to the success of the 1984 field season. The field crew, composed of Jane Dale, Bob Dawe, Doug Glaum, Karie Hardie, Chris Hughes, Rita Morningbull, Maureen Rollans, Lynn Tuk, Milt Wright and Eldon Yellowhorn, provided the balanced combination of excavation expertise and good humour which is essential to the success of any field project. We were fortunate to have the assistance of several volunteers over the course of the field season and their efforts were much appreciated. Thanks are extended to John Albanese, Kay Brink, Liz Bryan, Jody Dersch, Shirley Harpham, Cory Holland, Dave Hutchcroft, Beth Mann, Claude May, Alice Luchansky and Jason Adams for a job well done. The Head-Smashed-In guides provided support over the course of the summer and on several occasions Brian Yellowhorn was an inspiration to the crew. Thanks are also extended to the guides' supervisors, Dave McIntyre and Catherine Luck.

Access to the lands containing the Head-Smashed-In complex was kindly provided by Jim and Denise Calderwood, and expedited by their foreman, John Hester. The residents and merchants of Fort Macleod are thanked for their cooperation and many courtesies during the course of the summer. Armin and Gerry Dyck of Coaldale once again provided warm hospitality and volunteer services which are now an integral ingredient to the success of each field season at HSI. Edward and Brian Yellowhorn kindly provided us with information on other site locations, and Edward provided some valued personal recollections of the history of the HSI locality. Several representatives of the media visited HSI in 1984, but Dave Cooper of the Edmonton Journal is owed special thanks for his fine article on the HSI project. The film crew from the Access Network is thanked for their expert production, good humour and the beer.

The staff of the Archaeological Survey of Alberta provided the field support, lab resources, and office support that are essential to the success of the ongoing HSI project. Don Sutherland of the Mechanical Engineering Department, University of Alberta is thanked for the loan of the potentiometer and assistance with technical aspects of the experimental projects completed in 1984.

John Lodge expedited us into and out of the field with a minimum of fuss. John Priegert assisted in the coordination of lab analyses and storage of material remains. The onerous task of cataloguing and analysing the 1984 assemblage was accomplished with the assistance of John Albanese, George Chalut, Beth Mann and Kim Schultz.

The 1984 final report is the collective product of several people's labour. The initial chapters are collaborative efforts, but subsequent chapters and sections are largely the product of individual efforts. The senior author penned the chapters dealing with Drive Lane Cairns, Petroglyphs and collaborated with Doug Glaum on the faunal analysis. The analysis of the lithic assemblage was contributed by Bob Dawe, while Milt Wright provided the analysis of the remaining material remains and the discussion of spatial patterning of those remains. Wright also contributed the chapters dealing with experimental research into bison bone taphonomy and pit and hearth feature replication.

The collaborative structure of the report contributed to inordinately intricate and seemingly unending series of draft versions and the forebearance of the secretarial staff is much appreciated. Martina Purdon (a saint on earth) succeeded in converting these draft versions into a final readable copy, and the illustrations provided by Wendy Johnson contributed substantially to the report's appearance. Karie Hardie provided many of the photographic needs for the report and Kay Brink provided editorial comment on several chapters. The task of proofreading the overall report was capably handled by Gabriella Prager.

Throughout the course of the summer a number of individuals visited the site and contributed their respective expertise to one or more of the HSI research projects. The assistance and comments of Drs. John Dormaar, Ray LeBlanc, Cliff Hickey, Brian Reeves and Charlie Schweger are gratefully acknowledged. The continued support and encouragement of Drs. Bill Byrne, Paul Donahue and Dave Burley of the Archaeological Survey of Alberta is much appreciated.

A final word of thanks is extended to the many hundreds of tourists who visited us "pit-side" during the course of the project. We appreciated the well reasoned questions and thought provoking interpretations freely offered, but are still unable to provide an answer to the memorable question as to what time the buffalo start jumping.

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CHAPTER ONE

INTRODUCTION AND REPORT ORGANIZATION

INTRODUCTION

This manuscript is the second in a series of documents reporting on the archaeological studies conducted at Head-Smashed-In Buffalo Jump (DkPj-1) in southwestern Alberta (Figure 1). This work is funded by Alberta Culture as part of a multi-year programme of site interpretation and development. Head-Smashed-In (HSI) is a Provincial and National Historic Site as well as a U.N.E.S.C.O. World Heritage Site and has been selected by the Alberta Government for the development of a major on-site interpretive programme. To be completed by July 1, 1987, this project will feature a 2400 m^2 visitor reception centre (VRC) located a few hundred metres south of the main kill site at HSI. The centre will present interpretive displays on the subjects of the plains environment, plains Indian culture, the operation and archaeology of the jump, and the discipline of archaeology. Site tours will also be offered.

The decision to develop the site initiated a need for further archaeological work beyond that conducted over the past four decades by previous researchers. These additional studies have two primary goals: 1) to conduct archaeological work necessary to investigate and mitigate any potential impacts to prehistoric cultural materials as might be brought about by land surface disturbance associated with site development, and 2) to conduct basic research on aspects of the site which are still poorly known so as to enhance the overall quality and scope of the interpretive programme.

Fieldwork addressing both these goals began in the summer of 1983, and the results have been previously published (Brink et al. 1984, 1985). As to be expected, first attention had to be devoted to examination of the areas at HSI identified for development. This task consumed most of the archaeological activity for the 1983 season. Time and resources allowed for brief attention to our second goal, and this consisted of a preliminary test of the archaeological record of the camp/processing area adjacent to the kill site. Much, though not all, of

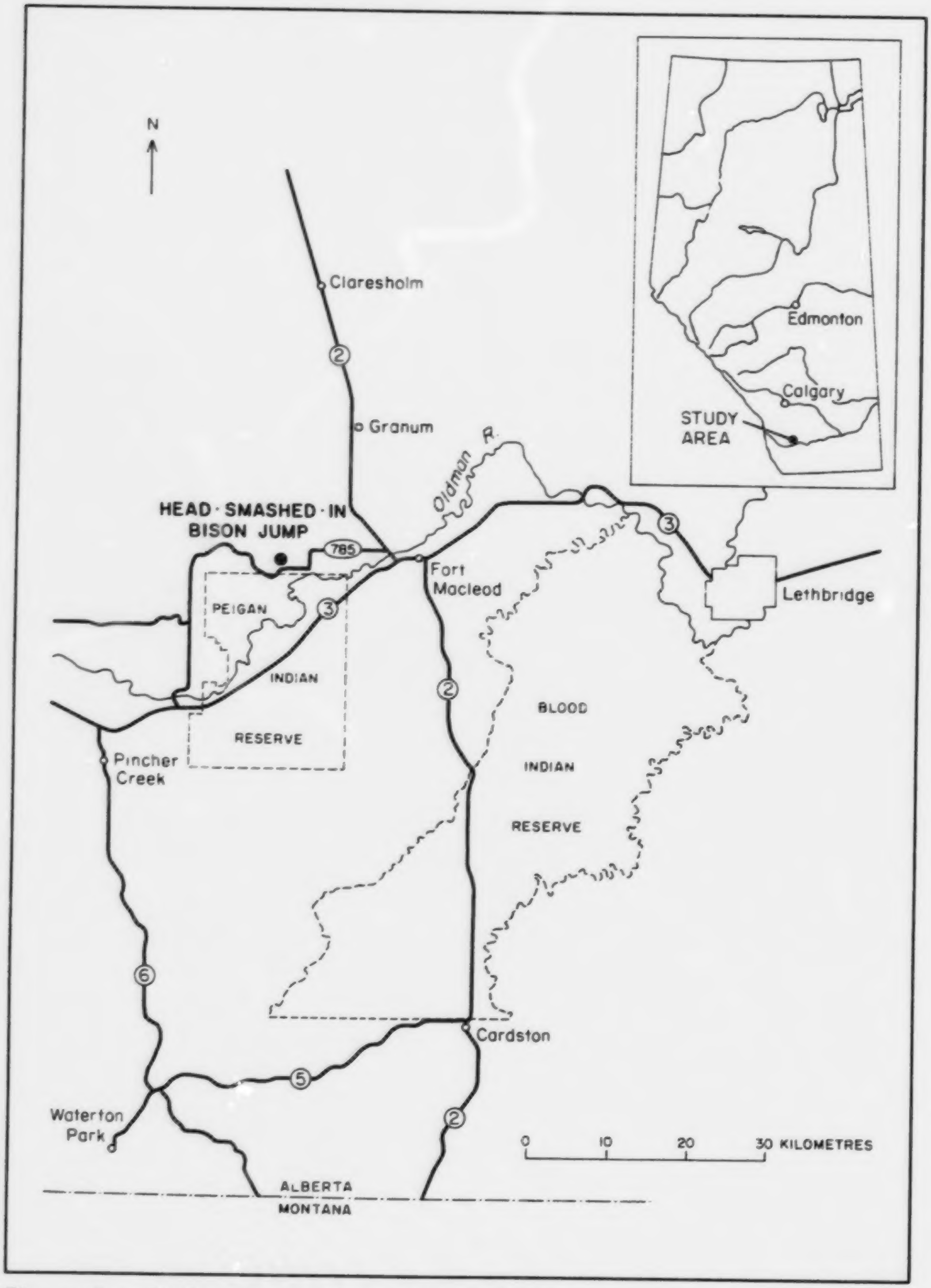
N
Claresholm
2
Granum
Oldman R.
HEAD·SMASHED·IN
BISON JUMP
785
Fort
Macleod
3
Lethbridge
PEIGAN
INDIAN
RESERVE
2
BLOOD
INDIAN
RESERVE
Pincher
Creek
6
Cardston
5
Waterton
Park
2
0
10
20
30 KILOMETRES
ALBERTA
MONTANA
Edmonton
Calgary
STUDY
AREA

Figure 1. Study area and location of DkPj-1.

the necessary development related fieldwork was completed in the 1983 field season. Thus, the proportion of time and resources allocated to the two main project goals for the 1984 season was approximately the reverse of the 1983 situation.

What follows is the final report for the 1984 season. A preliminary report has already appeared (Wright et al. 1985). In this first section we will present an introduction to the 1984 fieldwork by discussing the major studies conducted and the rationale for them. We will also outline the organization and content of the remainder of the report. As with our 1983 final report, this document will be largely descriptive. Where warranted, interpretations and speculations are offered. As the long term studies of the site continue, we expect to produce additional reports of more substantive results which are not dedicated to presentation of specific field season results. Also, this report will not duplicate major introductory sections provided in our 1983 final report. These include discussion of previous research at HSI, description and environmental setting of the site, and a description of the proposed development programme. Readers seeking information on these topics are referred to our 1983 report (Brink et al. 1985).

THE 1984 FIELD SEASON

Mitigative Studies

As mentioned, most archaeological work needed to explore the site areas where development was to take place had been successfully completed during the 1983 field season. However, some alterations to development plans continued through the 1983/84 winter, thus necessitating additional fieldwork. Two mitigative studies were undertaken in 1984: test excavation of a small site located in an area newly identified for a parking lot, and mechanical blading of parking and access road areas in an attempt to identify and excavate in situ features.

Exploration of potential access road and parking areas to the southwest of the main kill at HSI in 1983 revealed a general abundance of cultural material over most of the impact region. One exception was a small, level rise of land located 400 m southwest of the main kill site but which is still included as part of DkPj-1 (Figure 2, Parking Lot

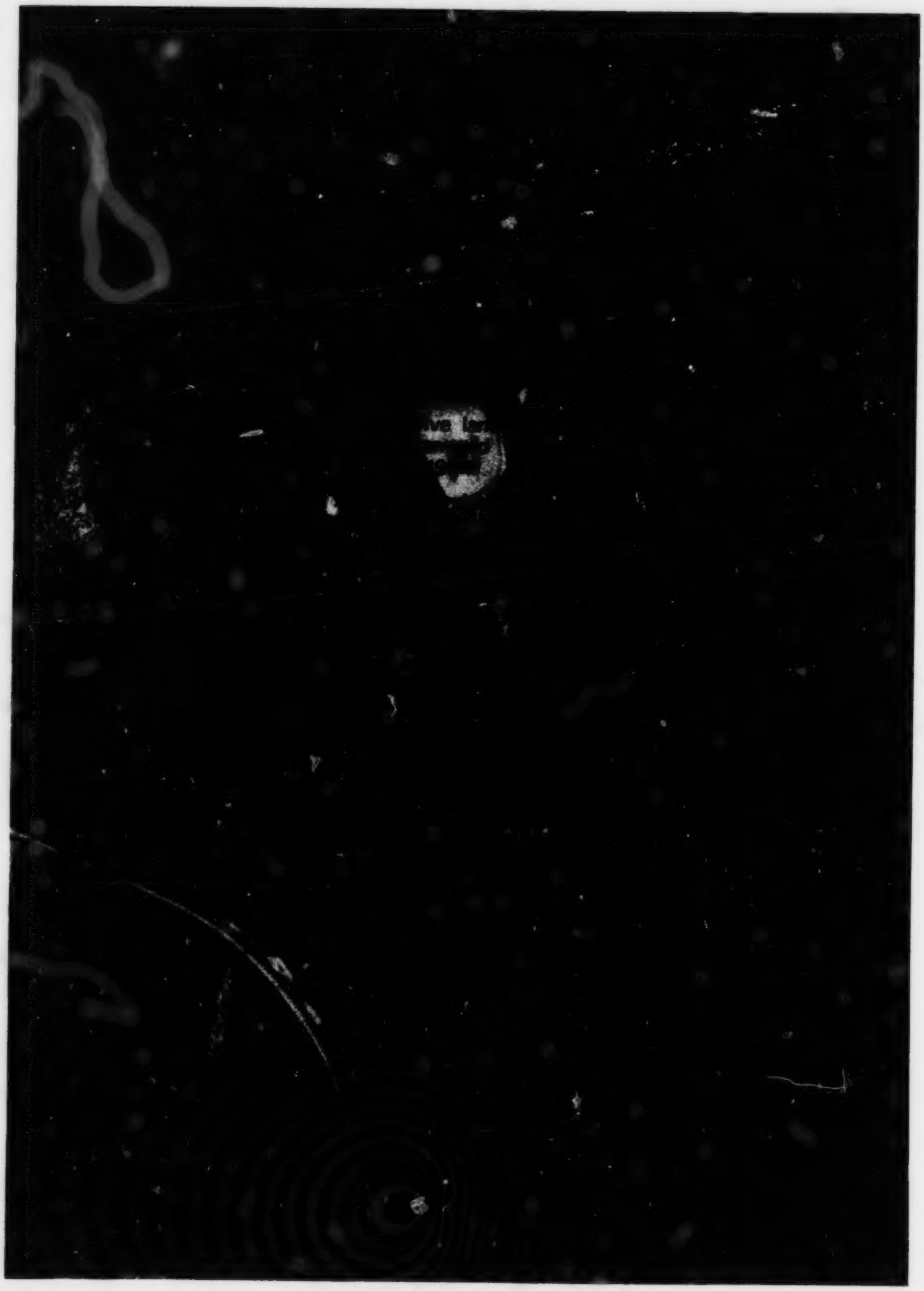

Figure 2. Aerial photograph of Head-Smashed-In site complex.

Excavations). A programme of systematic test pit excavations along the proposed access road and parking areas had indicated the presence of buried cultural materials on this small knoll. To explore the boundaries and content of the site, the area was gridded and tested with sixteen evenly spaced 50x50 cm test pits. Results of these tests indicated that the level top of the knoll contained a thin scatter of flaked stone, fire broken rock, bison bone, and a possible feature. While the amount of material recovered was relatively low compared with other areas of DkPj-1, the test pits revealed that several occupations were present and that these were stratigraphically separated by sterile layers of soil. This was considered significant in light of the general absence of stratified cultural deposits over most of the rest of the camp/processing site adjacent to the kill area. As a result, the top of the knoll was identified as an area to be avoided by construction.

However, over the course of the 1983/84 winter, design changes necessitated the use of this knoll for a parking lot. The decision was made to allow this development, but to mitigate site impact by excavation of a sample of the site prior to surface disturbance. The methods and results of this excavation are discussed in Chapter 2.

The second mitigative project for the 1984 season was also associated with the access road and parking areas to the southwest of the main kill site (Figure 2). Despite the very low recovery of artifacts from our 1983 tests of these areas, we did encounter several well preserved subsurface features. Features were a common occurrence in our testing of nearly all areas of DkPj-1 during the 1983 season. However, those features encountered in our research oriented studies of the core/processing area (Figure 2) often exhibited a confusing picture of contextual integrity due to repeated reuse of the area and lack of soil deposition. In contrast, features encountered in areas peripheral to the primary processing area often appeared to be largely undisturbed. That is, the 1983 field studies suggested that features in peripheral areas had not been seriously modified by reuse and as such were more easily, and presumably more accurately, interpreted as to their original function. We believe this to be due simply to the fact that these peripheral areas were used less often by the hunters operating the jump.

For these reasons we considered it worthwhile to excavate additional features from the development area. At the same time, it was recognized that discovering whatever features existed in these areas would be a labour intensive process as none are visible on the site surface. Hand excavation as a means of feature discovery would be very slow and would be unrewarding in terms of data recovery. It was decided that careful blading of the ground surface coupled with monitoring of the exposed soils would be the most productive means of feature discovery. Previous tests from 1983 had indicated that feature outlines could not be distinguished until at least 10 cm of the sod and Ah soil horizon had been removed. Thus we saw little danger of causing serious disturbance to the features by using heavy machinery to strip away the sod. The methods and results of this mitigative project are also discussed in the following section of the report.

Research Studies

As mentioned above, with most of the necessary mitigative studies completed in 1983, we were permitted in 1984 to begin addressing questions about the site which we felt needed additional study in order to both enhance the interpretive programme presented at HSI, and to contribute to the professional study of bison jumps and plains archaeology. There are a number of considerations which dictated limitations and points of emphasis for these research studies and these will be briefly discussed.

The major previous study of HSI was that fielded by Reeves in 1965, 1966 and 1972 (Reeves 1978, 1983b). While Reeves excavated at both the main kill site and on the prairie level processing area, his subsequent analysis and reporting of his work focussed almost entirely on the results of the excavations of the deep, stratified bone bed at the kill site. Hence at the start of Alberta Culture sponsored studies, this was the best known part of the site complex. It is also the more finite resource when compared with the vast horizontal extent of the adjacent processing area (estimated at about 1/2 km^2). It can also be argued that the 11 m deep bone bed is the single most significant portion of the site. For all of these reasons, it has been assumed from the outset of our project that further work in the kill site deposits will probably not be attempted. While it is certainly true that a great deal more could be learned from further study of the HSI kill site, it is equally true that the lack of information for other areas of the site should first be addressed.

A second consideration involves recognition of the fact that the interpretive programme for HSI includes the provision for continued field investigation of the site for many years to come. That is, archaeological excavations will be conducted every summer after the interpretive VRC opens, and these will be an integral component of the public's interpretive experience. As such, these excavations will necessarily be restricted to the immediate site area where the public can visit the excavations on a series of hiking trails. The potential to pursue off-site studies of HSI and the surrounding region will decline or disappear once the centre opens in 1987. Similarly, the post-1987 excavation programme will be largely restricted to excavations in the areas encompassed by the trail network, which will probably be confined largely to what we call the "core" of the processing area (Figure 2).

For these reasons, we have directed our research at aspects and areas of the site which we feel deserve further attention but which have little potential for additional detailed study once the VRC begins operation. For the 1984 season, these included two categories of projects: off-site studies of archaeological data related to the overall use of the site or to the general prehistoric use of the area, and on-site research in areas peripheral to the primary or core processing area. These will be briefly summarized below.

In 1984, three research projects were initiated which were located away from the immediate kill/processing area of HSI. The first of these, a preliminary study of selected drive lane cairns, is clearly and directly related to the use of the site. The second, an investigation of petroglyphs above and to the west of the jump-off, may or may not be directly related to the use of HSI - this point will be argued in the appropriate report sections. The third, a study of a vision quest site located on a hilltop to the north of HSI, is not believed to be directly related to HSI. All three projects are linked in that they represent exploration of aspects of plains Indian culture which we believe to be of interest to the general public and as such could make useful contributions to both the on-site interpretive programme and to the available literature on plains archaeology.

The general layout of the drive lane system at HSI was provided by Reeves (1978). As our study of the site continued, it became apparent that this massive system needed much additional study. The first requirement was a detailed mapping project to accurately record the location of lanes of cairns on topographic maps and aerial photographs. This task was contracted to Reeves and, as of this writing, is in progress. Secondly, our review of published literature on drive lanes at communal bison kills revealed an almost complete lack of serious study of the construction and function of alignments of rock cairns. A straightforward role of these features in channelling bison towards the desired kill has apparently been assumed by the plains archaeological community. To our knowledge, only Frison (1974, 1978) has speculated at some length on cairn function. In an attempt to rectify this situation, we began a very preliminary study of selected drive lanes and cairns in 1984. This investigation involved limited mapping, lithological analysis and test excavation of a sample of cairns. The results of this work are presented in Chapter 6 of this report. If nothing else, our investigation indicates a need for much additional research into construction and function of the HSI drive lanes. Maureen Rollans, a University of Alberta graduate student, is taking on this topic as her Master's degree research and will be continuing field studies at HSI in 1985.

The existence of petroglyphs at HSI has been known for many years. The location of one glyph site is plotted on a photograph of HSI taken in 1938 by Junius Bird. However, there has never been an attempt to survey the region to inventory all glyphs, nor have the known ones even been recorded. In 1984, we decided to inventory and record all the glyphs in the proximity of the HSI kill site. Two glyph sites were recorded, one on each side of what Reeves (1978) has termed the "south pass", which is a primary channel leading from the bison collecting area in the Olsen Creek basin to the jump-off (Figure 2). The positioning of these glyphs on each side of this important drive system may argue for a relationship between the rock art and the operation of the jump, or it may simply be fortuitous. The fact that a number of rock art sites in Alberta are associated with bison jumps (Brink 1981) tends to support the former interpretation. Regardless of possible associations with the jump, the rock art represents an interesting aspect of the site and one which could conceivably generate a high level of public interest. Hence, we decided to investigate the HSI glyphs in order to incorporate data on these features into the interpretive programme, as well as to simply augment our overall knowledge of prehistoric resources in the site area. The details of the petroglyph study are presented in Chapter 7 of this report.

The existence of a vision quest site on the top of a high hill some 3 km north of HSI had also been widely known. During the years of Reeves' work at HSI, Ron Getty recorded this site as DkPj-13 and, although the legal description given at that time was incorrect, it is clear that this is the same site as we investigated. Changes in Borden numbers have resulted in this site now being designated as DkPj-21.

Unlike the drive lanes and glyphs, it seems most unlikely that the vision quest site was constructed and used in association with the use of HSI. We have not seen reference in plains Indian ethnographic literature to any link between these two activities. But again, the presence of a vision quest in the immediate site area adds an interesting dimension to the HSI interpretive programme, and it was decided to include this in our 1984 research programme. DkPj-21 was completely mapped in detail and photographed. A surface collection of artifacts was made and two small shovel test holes were excavated. Under our direction, work at this site was conducted by Christopher Hughes of the University of Alberta as research for his honours B.A. degree. A slightly revised version of this honours paper is included in this report as Appendix 1.

Research studies conducted in 1984 which relate more directly to the archaeological record of the camp and processing site include a block excavation, 7x8 m in size, located on the northern periphery of the core processing area, and experimental studies of hearth and boiling pit features and bison bone taphonomic alterations.

As indicated above, a variety of considerations have resulted in the decision not to continue archaeological studies of the HSI bone bed but instead to focus on the little known record of bison processing. It was also noted that since long range interpretive archaeological excavations will be conducted in the core area of the camp and processing area (as determined from our 1983 surface survey and subsurface testing), we will direct more attention to the peripheral site areas which will be largely unavailable for study after 1987. A further incentive for the examination of an area removed from the core processing site was provided as a direct result of our 1983 testing of the latter area.

Scattered excavation units in the core area revealed an extremely dense deposit of cultural material contained in the upper 20 cm of soil. Lacking any stratigraphy and obviously subjected to a multitude of occupations over several thousand years, this compressed cultural deposit presents enormous problems for analysis and interpretation. Although these problems must eventually be addressed, our priority was to gain as much of an understanding as possible of the activities and material culture associated with bison processing at HSI. Again, this was motivated by our need for information on this topic (generally lacking in the reports of previous research at HSI) to augment the public interpretive programme. It was our speculation that excavations in a more peripheral area might present less problems from reuse and disturbance simply because these areas have attracted less cultural activity over the history of site use. Thus, although we had every reason to believe that these areas of the site would suffer from the same lack of soil deposition and resultant coalescence of multiple occupations, we suspected that the archaeological record in areas used less often, and possibly by less numbers of people, might prove somewhat easier to decode. This, not tackling the massive complexity of the archaeological residue in the core area, was our primary objective in 1984.

Thus, a major part of the following report deals with the recovery and analysis of the archaeological materials, and their spatial relationships, excavated from the 56 m^2 block located about 100 m north of the northern extent of the core area (Figure 2). We know that cultural materials extend much further north than our chosen excavation area, but we were concerned that movement too far from the core area could result in the excavation of materials whose relationship to the usual activities associated with the processing of bison after kill events at HSI would be open to speculation. The area chosen for excavation was an attempt to balance the goal of recovering a less complex record than that found in the core area with the desire to excavate materials which are unquestionably associated with processing of bison at HSI. Now that the work is completed, we believe we were successful. However, until more detailed studies are conducted in the core area, and thus can be compared with our results, we will be unsure whether the artifacts and activities which we document are in fact representative of the site as a whole. The possibility must be entertained that some peripheral areas of the site served specialized purposes, although we do not believe that the data on hand from 1984 support this idea. The methodology and all results and interpretations from this excavation are presented in Chapter 3.

Finally, the 1984 season also marked the beginning of a series of experimental studies which we intend to continue for several years. All of the experiments have as their primary goal the generation of base line data which we would then be able to employ as an aid in interpreting the archaeological record from HSI, especially with respect to bison processing. Experiments were aimed at two specific topics: studying the activity of bone boiling for grease extraction, and beginning a long term study of taphonomic processes affecting bison bones left on the prairie near the site. Both sets of experiments were only initiated in 1984 and will be continued in subsequent seasons. Hence, results presented here are still very preliminary. The taphonomic experiments are presented in Chapter 4. The hearth and pit feature experiments are detailed in Chapter 5 of this report.

CHAPTER TWO

MITIGATION PROJECTS IN THE DEVELOPMENT AREA

INTRODUCTION

This section of the report deals with the final results of the 1984 excavation projects in the development area of Head-Smashed-In Buffalo Jump and is presented in two parts. The first part considers the results of a test excavation programme to evaluate the impact of a new parking lot which is located in an area known to have the potential for buried and stratified archaeological deposits. The second part discusses the results of a monitoring programme which was undertaken in conjunction with the initial grading of the access road and parking lot areas. Following the detailed discussion of the significant archaeological remains recovered from the various projects noted above, a summary is presented which discusses the recommendations of the 1984 mitigative programme at HSI.

The development area has been the focus of previous field investigations at HSI (Brink et al. 1985), and much of the development area had been cleared for construction prior to the 1984 field season. During the next two to three year construction phase, it was anticipated that much of the remaining archaeological study of this area would be limited to monitoring initial construction activities (Brink et al. 1985:58). However, changes to the parking lot location were made over the course of the 1983/84 winter necessitating further field studies.

The placement of the new parking lot coincided with an area that had been subjected to intensive test evaluation in 1983. This testing included shovel tests and 2 m^2 units. In contrast to the main processing area, the test area revealed stratified deposits containing thinly scattered bison bone and other cultural remains at depths of 10 to 90 cm below surface. The presence of these deposits encouraged the exclusion of this small area from future construction activities pending the analysis of the excavated data. These studies revealed that the depth of the deposits belied their age and that the bone recovered was consistent with a scavenged assemblage, most of which appeared to have been secondarily deposited as slope wash (Brink et al. 1985). The few artifacts recovered were of uncertain context and at best represented incidental use of this far removed portion of the camp and processing site.

These research results indicated that this small area need not be excluded from development and that the southern portion of the proposed parking lot could be installed following monitoring of initial stripping. The northern portion of the lot included areas that had only been minimally tested in 1983, and the results of these tests indicated that further evaluations would be required prior to development.

The land surface in the development area is composed of several small, flat-topped hills which are separated by shallow east/west trending drainage channels. The characteristics of this land surface are evident in Figure 3 and test excavations have indicated that these topographic features can exert significant control over intra-site settlement patterning. For example, the results of our test excavations conducted in 1983 demonstrated that the level ground surfaces were the preferred occupation areas and that even the presence of a few degrees of slope would substantially reduce the amount of culture material present. It was also evident that the low lying drainage channels were providing sediment traps and that these locales yielded the only distinct paleosols found at HSI. Although we expected to encounter relatively few remains in the course of the 1984 testing of the development area, the potential did exist for the recovery of deeply buried and, therefore, potentially significant archaeological remains.

EXCAVATION METHODOLOGY

The evaluation of the northern section of the parking lot was accomplished with four 2 m^2 units. The units were labelled according to the previous year's nomenclature as area 12, units 5 through 8. Two of these units (5 and 6) were placed kitty-corner within the northern third of the parking area, while the remaining units (7 and 8) were joined to form a 2x4 m unit along the northern edge of the proposed parking lot (Figure 4).

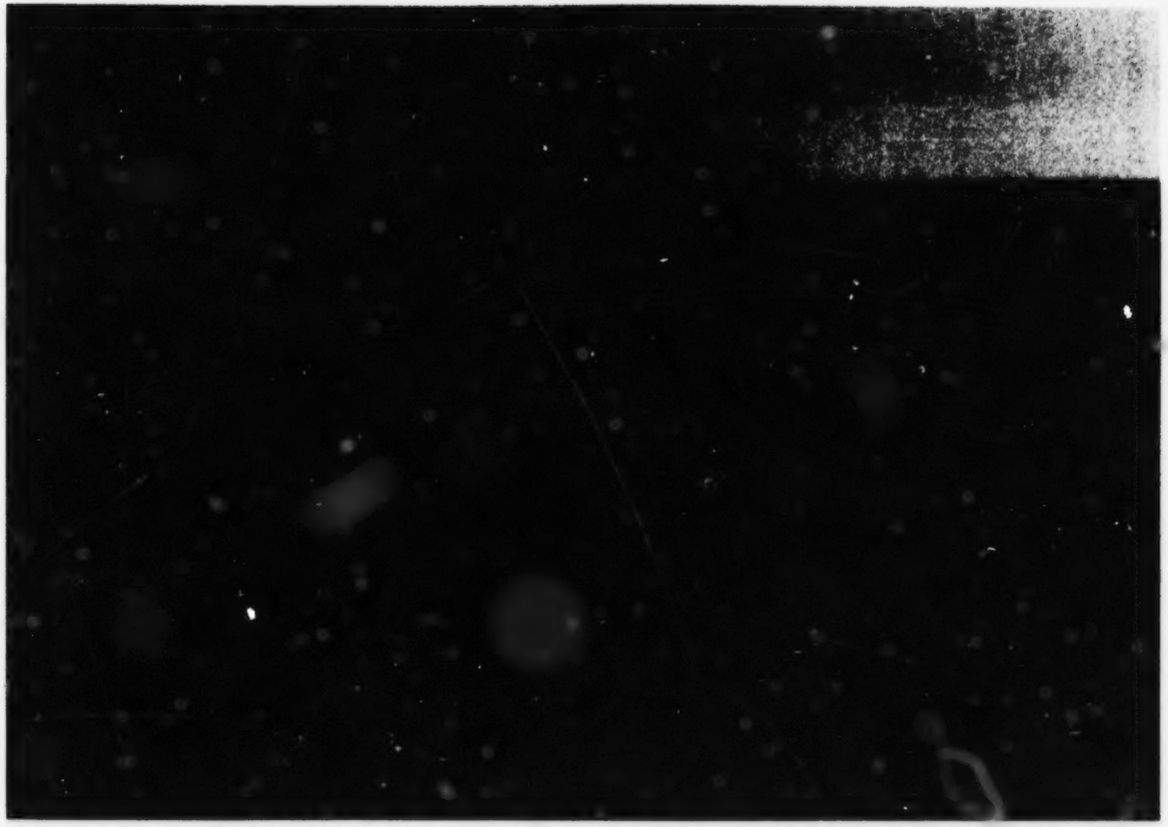

Figure 3. General view of development area test excavations, Area 12.

Figure 4. Aerial view of development area test programme, Area 12.

The excavation methodology employed natural levels excavated in 10 cm increments. For the most part, this was accomplished with shovels and proceeded by 50 cm^2 subquads. All of the matrix was passed through 1/4 inch screen, and all cultural remains were retained. In the exceptional case of a feature or bone concentration, the remains were photographed and plan maps made of the bone and fire broken rock deposits. By and large, most of the detailed recording of bone and stone concentrations was restricted to units 7 and 8, as the other two units contained comparatively few remains.

The discussion of excavation units can therefore conveniently be divided into two parts. While units 5 and 6 proved nearly sterile, units 7 and 8 contained significant deposits of bison bone, some in articulated context, along with rock features and several lithic artifacts. The structure of these deposits and the description of features recovered are discussed below; the analysis of the artifacts recovered is found elsewhere in this report (see Chapter 3, Analysis of Material Remains).

EXCAVATION RESULTS

Units 5 and 6

These 2 m^2 units were excavated by shovel, using natural levels which were removed in 10 cm increments. At a depth of 40 cm, both units were downsized to 1 x 2 m units and excavated to a depth of 110 cm using the same methodology. The substrate in these units was compact and extremely dry and proved difficult to screen because of the large soil peds. The units proved to be the least productive of all those excavated in 1984, containing no identifiable bone and yielding only a single point fragment in a total of six cubic metres of sediment. The profile of the units revealed several episodes of paleosol development, the majority of which were thin and discontinuous, containing few if any remains.

The exception to this rule was a thick paleosol extending from approximately 10 cm to 40 cm below surface which contained the majority of the bone and fire broken rock recovered from these two units (Figure 5). Only in unit 6 was there a sufficient concentration of fire broken rock fragments to warrant a plan drawing. This revealed a roughly circular distribution, but the absence of hearth staining, pit

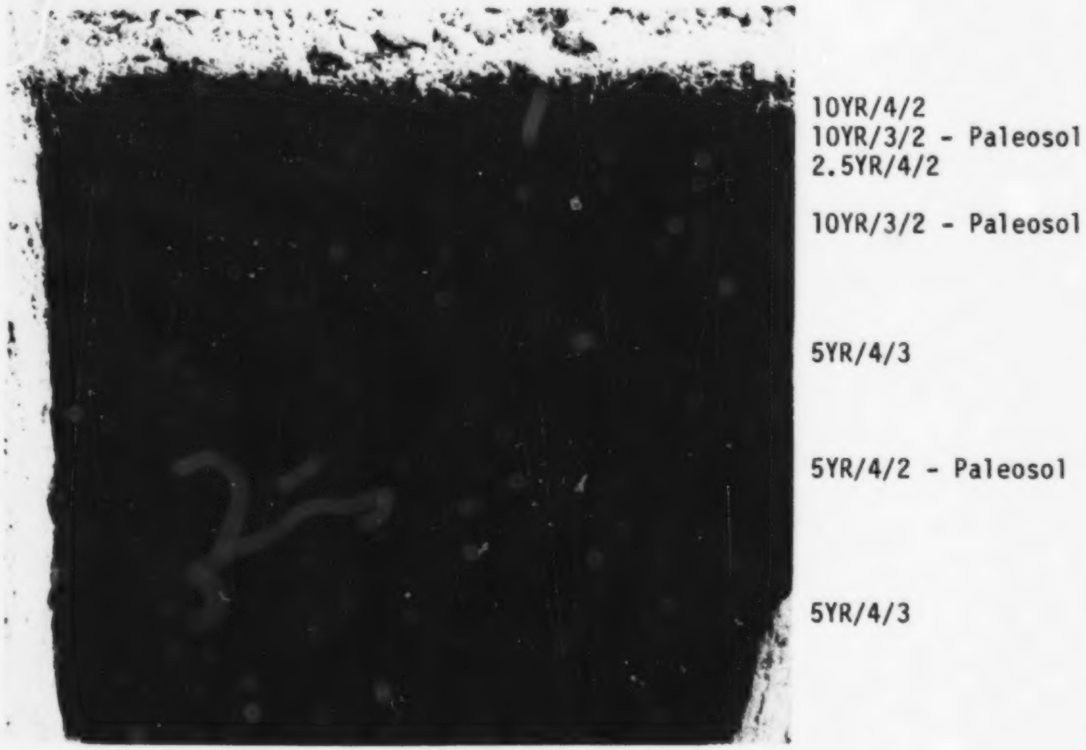
10YR/4/2
10YR/3/2 - Paleosol
2.5YR/4/2
10YR/3/2 - Paleosol
5YR/4/3
5YR/4/2 - Paleosol
5YR/4/3

Figure 5. North wall soil profile, Unit 6, Area 12.

depression, or artifactual remains renders this concentration enigmatic. Based on the results of these findings, which were in close agreement with the 1983 results, there seemed no justification in the further exclusion of this particular area from development.

Units 7 and 8

These 2 m^2 units were placed on the northern periphery of the proposed parking lot in an area that was lower in elevation than units 5 and 6 and that coincided with a small drainage channel (see Figure 4). Owing to enhanced moisture levels, this area is covered by a thick growth of rose bush, creating a tangle of roots within the upper 20 cm of both units. Shovel test results in 1983 indicated that this area produced abundant and well preserved faunal remains. However, we suspected that some or all of this bone was in secondary context and redeposited as channel fill during major episodes of erosion and slope wash.

Both units were excavated using a similar methodology to that specified for units 5 and 6, with the exception of the use of shovels. The abundance of faunal remains in units 7 and 8 often required trowels and grapefruit knives to be employed. Because these units are situated in an infilled drainage channel, the sediments are not distinctly stratified, but appear as a thick Ah soil horizon extending from the present land surface to the surface of the relic channel (c. 90 cm). In unit 7, the interface between the channel fill deposits and the relic surface is clearly defined with the deposits steeply sloped along a north-south axis. This made excavation of natural levels very difficult, for the top of a natural level in one portion of the unit was sometimes 40 cm above the same surface downslope within the unit. Fortunately, the archaeological deposits were not complicated, and although fragments of bone and fire broken rock were found throughout these deposits, the majority of faunal remains and a rock feature were found in a gently sloping, layered deposit of unit 8, approximately 50-90 cm below surface. A detailed breakdown of the bone elements recovered from these units is presented in the section concerning the analysis of faunal remains (see Chapter 3). This opportunity is taken to present some hypothetical explanations of the origins of these deposits.

The first possibility to be considered is that the remains in the channel are the result of slope wash and that all the remains are in a redeposited context. We would predict, therefore, that some degree of sorting should be present, both with respect to the orientation of the bone (Behrensmeyer 1978) and the kinds of elements present (Brink and Morlan 1983). At the same time, we would not expect to find any intact features or assemblages of articulated bone that could be taken as evidence of primary butchering activities or in situ processing of meat portions and other by-products.

The antithesis of the latter explanation holds that the deposits are in primary context. Therefore, we would expect the presence of a greater variety of bone elements (some of which may be articulated), the presence of features and evidence of the tools that may have been used in the primary butchering of the remains. The hypothetical presence of primary and secondary butchering of bison remains in this peripheral area of the camp and processing site poses some fundamental questions. For example, do these remains represent carcasses that have been transported from the kill site? If not, by what means did bison arrive at this location some 400 m from the main kill site?

Any evidence of primary butchering negates the suggestion that the remains were transported from the kill site and, even in the presence of secondary butchering, it is highly unlikely that quarters would be transported such a distance. These remains must therefore represent the local killing of individual or small groups of animals. Such remains could be accounted for in two ways: one, that the animals are stragglers from the main stampeding herd and which presumably broke through the drive lanes (see Chapter 6); or two, that they are animals not associated with a communal kill event at all but rather were killed on an opportunistic basis by stalking.

Despite the best efforts of the people operating the drive lanes, it is likely that some animals escaped during the course of every jump event. It is likely that such animals would continue to run for some distance and the natural breakout point from the "south pass" at Head-Smashed-In would result in these animals terminating their flight at the development area (see Figure 2). While the cliff edge is extremely eroded at this location, it and the pitch of the slope would no doubt cause running animals to lose their footing and be momentarily incapacitated. Presumably, the residents of the camp and processing site could have taken advantage of such windfalls and quickly dispatched the few animals involved.

The second possibility is that the animals were not part of a communal hunt but represent the stalking and/or ambush of bison that are likely to have persistently frequented the area below the cliff slopes given its permanent water supply and luxuriant forage. This particular area would be ideally suited for a winter kill, whereby the animals could be immobilized by the deep snow that would accumulate in the area of the relic channel. In light of these two possibilities, we can now turn our attention to the detailed evaluation of the material remains recovered from units 7 and 8.

The density of faunal remains varied markedly with respect to the slope of channel deposits and the depth of the excavation unit. Unit 7 occupied the northern edge of the drainage channel, and here the deposits were steeply sloped to the south and contained relatively few remains of bone or stone. In contrast, unit 8, which was located directly south of the former unit, appears to have intersected the deepest deposits of the channel fill and, correspondingly, the greatest concentration of bone and stone remains. Given the choice, it seems most likely that the more nearly level surfaces of the channel would be preferred if bison remains were processed in situ. By the same token, given gravitational forces, an assemblage of bone that had been redeposited by slope wash would ultimately end up in the bottom of the channel rather than on the sides. The majority of the bone in unit 8 was recovered from between 50 and 90 cm below surface.

Although the deposits of unit 8 are not nearly as steeply sloped as those of unit 7, it is evident that remains recovered at 50 cm below surface on the north edge of unit 8 could be expected to occur at 70 cm below surface in the southern portion of the unit. These deposits are thought to represent a single layer of bone that, through sedimentation processes, has been dispersed and infiltrated with alluvium and loess such that its single depositional status has been effectively blurred. The level plans of these bone bearing deposits indicate that many of the bone elements are in approximate anatomical position and, in some cases, certainly articulated (Figure 6). Despite its relatively good state of preservation, none of this bone reveals what could be confidently identified as butchering marks. Neither was there an association of other remains such as numerous bone fragments, stone tools, or pit features that might provide evidence of in situ butchering and processing of bison remains.

There was a large rock feature in association with the bone. Presumably, this was a hearth and cooking facility (Figure 7). This feature was composed of 38 pieces of quartzite and limestone rock cobbles, weighing a total of 28 kg. Some of the rocks in the feature weighed in excess of 4 kg each. Certainly the size of the rock in this feature makes it an unlikely candidate for a stone heating facility which could have been used in conjunction with a boiling pit feature. The size of this feature is exceptional compared with the known stone features and hearth facilities at Head-Smashed-In (Brink et al. 1985). This may add some support to the hypothesis that the remains in unit 8 represent the proceeds of a winter kill and that the associated stone feature provided both a source of heat as well as a cooking facility for the group that initiated the kill.

The nature of the remains recovered from units 7 and 8 present a marked departure from those which would be expected in a processing site where most of the activity was presumably focussed on secondary butchering and further processing of the bison remains. The evidence of anatomically ordered bone elements and intact rock features suggests that these deposits are not the result of secondary depositional agencies. They must therefore represent an in situ kill event. The remains appear to represent seven individual animals and, although it is impossible to determine if they were killed simultaneously, the layered arrangement of the bone is at least suggestive of their close association.

The dating of this event is problematic. Both absolute and relative dating techniques were applied in the analysis of this bone deposit. Bone obtained from the major depositional unit at 40-50 cm depth below surface yielded a C-14 estimate of 470±150 years:A.D. 1480 (AECV 62c) (Table 1). A Pelican Lake projectile point was also recovered adjacent to this bone layer and should date to approximately 2000 years before present (see Figure 70i). A second C-14 date was obtained on bone

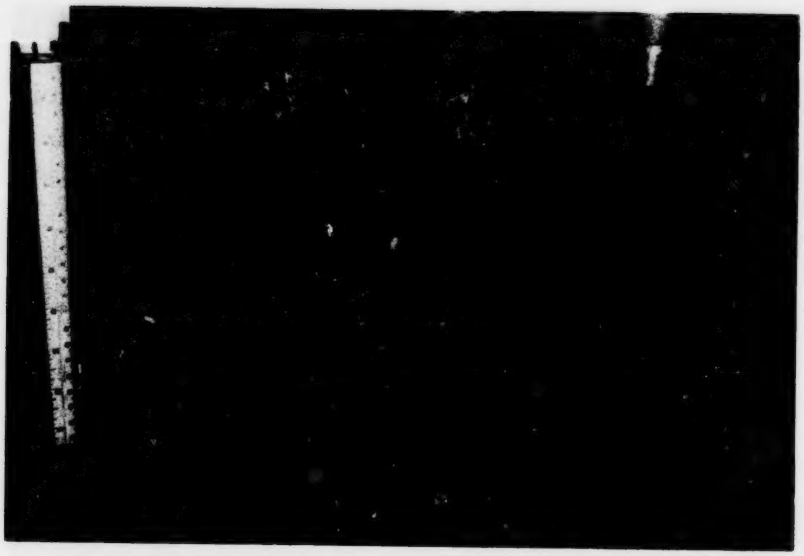

Figure 6. Articulated faunal remains, Level 4, Unit 8, Area 12.

Figure 7. Hearth feature, Level 7, Unit 8, Area 12.

Table 1. C-14 samples, Area 12

Lab	Provenience	Material	Date
AECV 54c	AREA 12 FEATURE 7	(W)	800±110
AECV 58c	AREA 12 FEATURE 9	(W)	890±120
AECV 62c	AREA 12 UNIT 8 LEVEL 5	(B)	470±150[+]
AECV 63c	AREA 12 UNIT 8 LEVEL 9	(B)	1140±90[+]

[+] Samples submitted for reanalysis.

(W) Wood charcoal

(B) Bison bone

recovered 40 cm below the latter bone deposit and this yielded an age estimate of 1140±90 years:A.D. 810 (AECV 63c). These results present us with somewhat of a dilemma. Either the typological assignment of the projectile point is incorrect, or it has been redeposited from another context by slope wash or rodent disturbance, or the dating estimates on the bone are simply incorrect. The bone samples were subjected to a second series of radiometric assessments and, although the final results are not available at the time of this writing, the preliminary results suggest that no substantial change in the C-14 estimates is likely to be forthcoming (David Arnold, pers. comm. 1985). We therefore must conclude that the projectile point, though correctly identified as a Pelican Lake point, is in a redeposited context.

Although the remains recovered from these units are part of the peripheral camp and processing site, they are exceptional and not representative of the normal course of secondary processing activities. These remains are therefore of little assistance in addressing questions regarding the camp and processing site deposits, but they are significant in the sense that they represent one of a very few sources of well preserved, buried and stratified archaeological deposits at Head-Smashed-In. We therefore recommended that the parking lot design be modified to avoid any disturbance of these deposits as a consequence of construction activities. As these deposits were already located on the periphery of the parking lot, there were relatively few design modifications required to comply with our concerns over the archaeological deposits. Based on these recommendations, the parking lot was shifted slightly to the south and the amount of cut and fill reduced to ensure that buried deposits will not be impacted. This recommendation applies only to the small channel which forms the northern edge of the proposed parking area. A few metres to the south, on the level bench where units 5 and 6 were located, cultural materials are so scarce that neither protection from development nor additional mitigative excavations were warranted. We recommended that parking lot development be allowed to proceed up to the edge of the small channel and that the surface stripping of the lot be monitored in order to recover archaeological features. The results of this monitoring programme are discussed below.

ACCESS ROAD AND MONITORING

At the close of the 1983 field season, the entire access road alignment had been tested and cleared for construction. Over the course of the ensuing fall and winter period, some design changes required that we augment our testing programme to account for minor alignment shifts and relocation of a number of secondary parking areas. Fortunately, the proposed access road is coincident for the most part with the previously disturbed ditch deposits adjacent to Secondary Road 785 (see Figure 2). These areas required no test evaluations in 1983, and changes to the road alignment along this particular section presented no threat to archaeological resources.

The last kilometre of the road alignment had changed in only minor respects from that proposed in 1983. At that time, we requested the presence of an archaeological crew to monitor the initial grading of the road surface. We requested that both the revised parking lot and the road alignment be accurately surveyed and marked in the field, and this was completed in June 1984. We then contracted a grader operator to complete the initial stripping of the entire parking lot and that portion of the road which we anticipated would reveal evidence of subsurface pit and hearth features (Brink et al. 1984). As mentioned in Chapter 1, our previous tests had indicated that this area yielded few cultural materials, but that in situ features would likely be present and would be worthy of salvage excavation. Mechanical stripping, rather than hand excavation, was deemed the most efficient means of discovering such features.

The grader operator was instructed to blade approximately 10 cm at each pass. The exposed surface was then visually inspected for evidence of bone and stone fragments and any indications of pit or hearth features. The windrows were also inspected and large, identifiable bone elements were recovered. The objective of this faunal collection strategy was to evaluate whether the remains in this peripheral area of the camp and processing site showed a marked departure from the kinds of remains being recovered in the core area of the site. On a purely impressionistic basis, the kinds of bison elements being recovered did not represent a significant departure from the faunal assemblage recovered elsewhere, with the possible exception of the presence of more immature animals in the parking lot and access road samples.

Features

Features exposed in the course of the road surface stripping were first flagged so further grading could be postponed until such time that a crew could shovel-shave, photograph, draw, profile and obtain a matrix sample from the hearth or pit fill (Figure 8). In all, nine features were recorded and sampled. They all occurred in the upper 20 cm of the deposit. These features obviously represent a range of specific episodes of site usage in this area over an unknown time frame. They are distributed over a wide area, and it is impossible to establish contemporaneity; only the basic descriptive attributes of the features are reported.

Feature One

This hearth feature measured approximately 80 cm in diameter and was defined by a reddish brown stain which surrounded a central ash pocket 40 cm in diameter. The ash pocket contained calcined bone, charcoal flecks, and a few fire broken rock fragments, and measured 5 cm in depth.

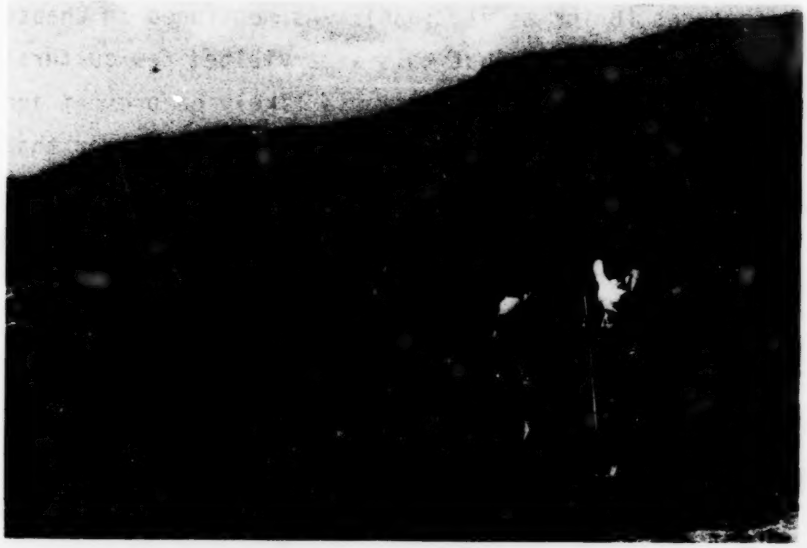

Figure 8. Exposing and recording features during parking lot test excavations, Area 12.

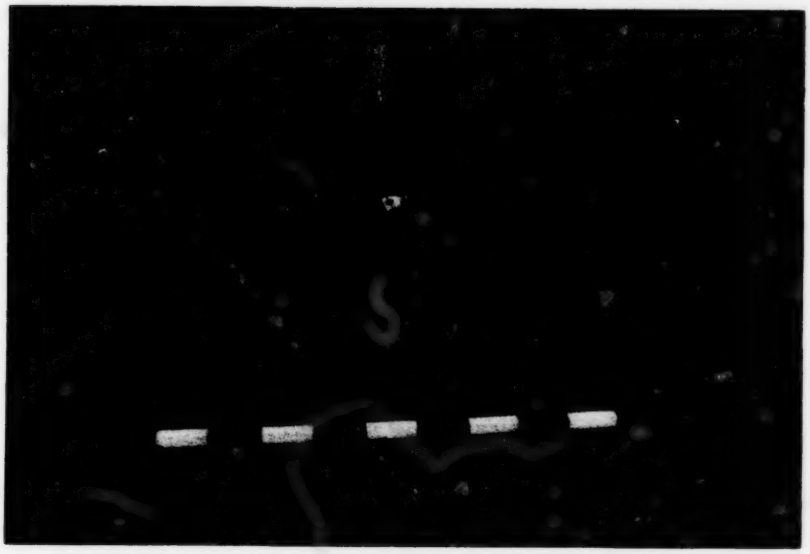

Figure 9. Profile of feature 7, Area 12 following removal of pit matrices.

Presumably, the blading and shovel-shaving removed much of the surface of this feature which would make its original depth significantly greater. The reddish brown stain is the result of oxidation processes, and the structure of the overall feature matrix suggests that it was a pit hearth which had been purposefully excavated. Presumably, this hearth could have been employed in cooking meat portions and heating rock for use in boiling pit facilities.

Feature Two

This non-pit feature is composed of a small assemblage of fire broken rock (n = 13, Wgt. = 1.7 kg) and several unidentifiable bone fragments. The circular configuration of the remains measures approximately 50 cm in diameter, and there is no staining evident in either a plan or profile perspective. This may simply represent a natural hollow in the prehistoric land surface which was infilled with a variety of surficially deposited residues.

Feature Three

This hearth feature measured 60x40 cm as marked by a reddened and ash-streaked matrix. The matrix contained some calcined bone, lithic debris and fire broken rock but did not extend into the subsoil any appreciable depth. Notwithstanding decapitation by the grader, it is suggested that this represents a shallow surface hearth that was not prepared as noted in the case of feature one. It is possible that a rock ring may have surrounded this feature, but no evidence of such remains were found in the vicinity of the feature, or the adjacent windrows.

Feature Four

This concentration of fire broken rock measured 80 cm in diameter and extended into the subsoil a further 8 cm below the exposed surface. There was no staining associated with this concentration, which was composed of 43 pieces of non-sandstone rock weighing 3.2 kg, and 64 pieces of sandstone weighing 5.9 kg, all of which revealed evidence of thermal alteration.

Feature Five

This small concentration of fire broken rock and bone fragments measured 30 cm in diameter and revealed no staining or noteworthy associations. The assemblage of bone and stone could have resulted from the infilling of a shallow depression via natural means, much like feature 2.

Feature Six

This assemblage of fire broken rock and bone fragments was dispersed over a one metre square area, and there was no evidence of staining. Notably, this feature produced a ceramic rimsherd with a complex decorative motif that is likely to have been the initial efforts of a juvenile ceramist (see Figure 62). The 26 fragments of thermally altered stone were all quite small, each weighing less than 70 g on average. The three bone fragments recovered were similarly small and represent unidentifiable mammal bone.

Feature Seven

This feature is actually a composite facility made up of a small pit containing charcoal and ash adjacent to a large pit containing an upper layer of oxidized sediment and a lower layer of sandstone fragments. The small pit measured approximately 30 cm in diameter and was 20 cm deep. Charcoal from this pit yielded a radiocarbon estimate of 800±110 years:A.D. 1150 (AECV 54c). The adjacent pit measured approximately 90 cm in diameter and was composed of an upper layer of oxidized sediment 5 cm in thickness and an underlying layer of sandstone fragments 10 cm in thickness. This assemblage of sandstone was extremely compact with little intervening loess, but it does not appear to be the result of the in situ disintegration of several larger pieces of sandstone. Very few of the over 400 pieces of stone which weighed a total of 23.6 kg revealed any evidence of thermal alteration. Certainly the sediments overlying the sandstone pavement had been exposed to direct heat, possibly from ash and burning fuel which may have been derived from the adjacent pit hearth. In this case, the heat would have been transmitted to the sandstone which would have then released the heat slowly and could have been used for roasting a variety of foodstuffs. The structure of this composite feature is clearly revealed in Figure 9, following the removal of the pit matrices.

Feature Eight

This hearth feature measures 80 cm in length and 65 cm in width but, due to an oversight, no depth was recorded. The hearth matrix is composed of dark sediments with abundant charcoal, ash, and several large pieces of fire broken rock (Figure 10). These fire broken rocks were all non-sandstone, each weighing on average just under 1 kg. This feature likely represents the remains of an excavated pit hearth that was used for cooking or heating rock for stone boiling.

Feature Nine

This feature is actually composed of three individual but adjacent pits and constitutes the most complex feature encountered in the parking lot area. Although it is possible that these separate pits are not contemporaneous, the fact that they overlap only slightly and are aligned on a SW/NE axis, suggests that they are part of a single complex facility (Figure 11).

The northernmost pit is 60 cm in diameter and 21 cm deep. The pit profile reveals a basal matrix composed of dark sediments overlain by an ash pocket, which in turn is capped by a distinct reddened layer of oxidized sediment. Given the depth of oxidation, there seems little doubt that this is the base of a pit hearth which was used several times. Immediately southwest of this hearth is an ash pit measuring 28 cm in diameter and 32 cm in depth. The perfectly cylindrical form of the ash and charcoal deposit looked suspiciously like an infilled post hole, yet there was no evidence of a sharpened base or residual wood to identify such an intrusive feature. The absence of any significant quantities of lithic or bone remains in the ash fill encouraged us to be circumspect in the identification of this pit as a prehistoric feature. Although similar features have been recorded outside the plains area, there are no examples from plains ethnographies or other plains archaeological sites that could account for such a feature (Smith and Cole-Will 1984). The radiocarbon assay on the charcoal from the ash pit yielded a date of 890±120 years:A.D. 1060 (AECV 58c), clearly

Figure 10. Plan view of feature 8, Area 12.

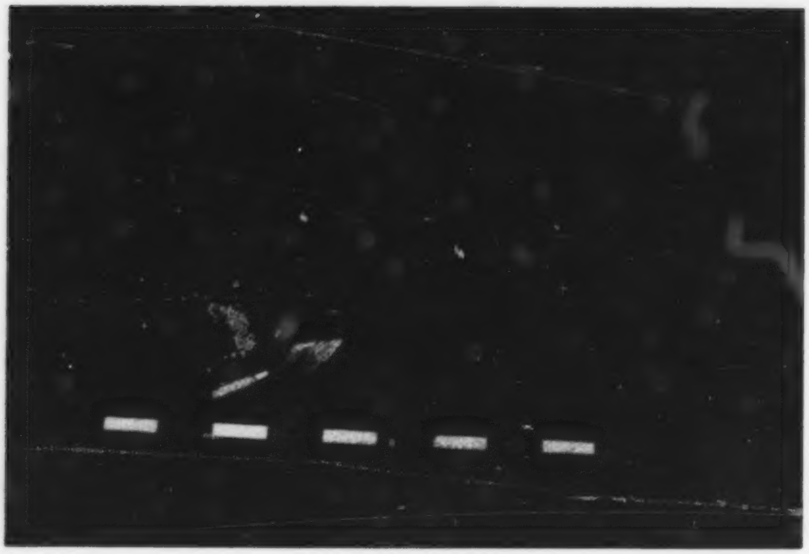

Figure 11. Plan view of feature 9, Area 12.

establishing the prehistoric status of this feature; its function remains open to speculation.

The final component of this feature complex is a circular concentration of fire broken rock and bone fragments which measures 50 cm in diameter and is located immediately southwest of the ash pit. The concentration of bone and stone is outlined by a dark stain which extends 5 cm into the subsoil. Although it is not evident in the plan view of this feature complex, the profile revealed that the aforementioned dark stain was joined with the dark basal sediment horizon of the large pit hearth described earlier. This common sedimentary horizon would appear to link all the above pits, providing an overall length of 1.8 m to this feature complex. At this time, it is unclear what caused this dark basal stain, but it is possible that it represents the remnant of an old living surface that was preserved within a depression and was subsequently superimposed by the features. We assume that this feature represents a hearth and roasting pit used in the cooking of foodstuffs. It is also conceivable that the cylindrical ash pit could have been used as a roasting facility, but no tangible residues of such an activity were recovered.

SUMMARY

The mitigative component of the 1984 field season at the Head-Smashed-In Buffalo Jump site included clearing the redesigned main parking facility and monitoring the initial stripping of the access road and aforementioned parking lot. Extensive test excavations during the previous field season had cleared most of the proposed development areas, but minor adjustments to the road alignment and relocation of the parking facility initiated further testing.

As a result of our testing in 1984, the design of the parking lot has been modified to avoid conflict with buried deposits of bone and stone features in the relic channel along the extreme north edge of the parking lot. Although these deposits yielded few lithic tool remains, they appear to represent a discrete bison kill event. Their deep burial makes them unique in light of the normal depositional environment at HSI. Initial clearing of the road and parking lot yielded a number of features, which we predicted would be the case based upon our 1983 test excavations. The nature of the assemblage recovered restricts the use of these data for comparative purposes, but they provide a glimpse into the activities which were conducted in this peripheral area of the camp and processing site. It is interesting to note that features in the development area provide consistently older radiometric estimates than those obtained from features nearer the core processing area (see Chapter 3). While features in the development area cluster around a mean estimate of 1000 years B.P. those from nearer the core area reveal mean ages of 500 years B.P. This is not to imply that older determinations are never associated with the central areas, but simply that on average the peripheral zone of the size (i.e., development area) appears to contain earlier evidence of occupation that is seen in the core area. Further investigation may ultimately prove this dating anomaly to be largely a consequence of small sample size.

We have recommended that the proposed parking lot development be altered to avoid cutting into the deeply buried channel deposits where well preserved bison kill material was recovered. This recommendation was acted on, and the elevation of the parking lot altered. Construction of the parking lot and access road was completed in the winter of 1984.

CHAPTER THREE

RESEARCH PROGRAMMES IN THE CAMP AND PROCESSING AREA

INTRODUCTION

The results of our previous year's study of the camp and processing site deposits at HSI resulted in the delineation of several basic qualities of the archaeological deposits below the kill site. On the basis of a surficial reconnaissance it was determined that the camp and processing site deposits cover several hectares of the prairie flats and intermediate slopes below the main kill site. Test excavations concentrated in the area immediately east of the kill site helped define some of the physical parameters of this complex archaeological deposit. Although the archaeological remains are distributed over a wide area, the density and depth of these remains varies consistently in an inverse proportion with increasing the distance from the kill site. We therefore partitioned the camp and processing site into a core area and a peripheral area (Brink et al. 1985).

The core area is located immediately below the kill site and south of the spring channel (see Figure 2). The cultural deposit in this area can be characterized as a homogeneous layer of broken bone and fire broken rock (FBR) that extends from the surface to a maximum depth of 30 to 40 cm below surface. These deposits are clearly the result of many sequential episodes of site use that have been compressed into an undifferentiated mass of artifacts, bone, stone and loess following several thousand years of trampling and deflation. In contrast, the peripheral areas of the processing site reveal fewer surficial remains and a maximum depth of deposits in the range of 10-15 cm. These cultural deposits were also deflated, but it is clear from the context of the remains that they have not been as severely turbated by post depositional agencies as is the case in the core area.

Our research design for the 1984 field season focussed on the task of delimiting the kinds of activities which were represented by the camp and processing deposits. We surmised that these activities included a range of secondary butchering practices: stripping and drying meat sections and food preparation using a variety of hearths, boiling pits and roasting pits. We also suspected that some of these activities might be manifest in the distribution of the hearth and pit features and associated concentrations of faunal remains, FBR clusters and artifact distributions. The excavated data from the 1983 field season provided some initial indications of these kinds of activities, but the limited sample size, extensive post-depositional disturbance and the small size of our excavation units (i.e., $2m^2$) precluded a detailed evaluation of any spatial relationships. The evaluation of spatial relationships required that data be obtained from large excavation units placed in areas that were likely to have retained intact contextual relationships between faunal remains, FBR, features and artifact distributions.

The results of our previous test excavations indicated that the core area was not a suitable location for the evaluation of spatial data (Brink et al. 1985). The core area has been the scene of multiple occupations and this greatly inhibits the evaluation of contextual relationships (Thomas 1983). Areas that are peripheral to the core of the site are likely to have been occupied less often and the remains may yet retain some contextual integrity.

It was also evident from our previous testing that sloped areas at the foot of the kill site and sloping surfaces on the prairie flats below the kill were rarely the scene of extensive occupation. We therefore sought out level locations that were both elevated and relatively near the core area of the site. Campsite debris consisting of bone fragments, FBR and artifactual remains can be found over a distance of a kilometre paralleling the cliff face and, although much or all of this deposit is probably related to the use of Head-Smashed-In, proximity to the kill site was of concern when selecting an area for testing. Ultimately, a level terrace to the north of the spring channel, and less than 200 m from the kill site, was selected for intensive evaluation (see Figure 2).

The ground cover in the vicinity of the terrace is largely composed of mixed prairie grassland species (i.e., shallow fescue, wheat grass, needle grass), and this cover is easily destroyed by trampling and rodent activity. Cattle trails and innumerable rodent push disturbances in the area of the terrace revealed abundant artifactual remains. There were several large sandstone rocks that were more or less aligned in a curvilinear fashion, suggesting that a tipi ring feature was present. Initial excavation of a 2 m square revealed a shallow deposit of densely packed FBR and bone from 0-20 cm below surface. Deep testing of this unit revealed that the Ah horizon was a shallow root mat with an average depth of 8-10 cm and composed of dark brown silts and sands. The underlying B horizon was a massive deposit of loess extending to 1 m below surface. This soil horizon was infiltrated by rodent burrows and dessication cracks extending from surface to 30 cm in depth. No parent material was identified in the course of the test excavations, and the soils largely mirrored the structure found throughout other areas of the camp and processing site (see Brink et al. 1985).

Although the deposits were clearly the result of more than a single occupation, the degree of admixture and trampling of tne deposits appeared much reduced from that exhibited in the core area. The excavation was therefore expanded by adding adjacent 2 m squares until, at the completion of the field season, a 7x8 m block excavation had been completely excavated to a depth of 20 cm below surface. A single 2 m square (unit 24) was located outside of the block to determine the homogeneity of the deposit, and revealed that the entire terrace had been the scene of extensive occupation (see Figure 12).

EXCAVATION METHODS

The excavation methodology employed in 1984 differed in a variety of respects from that which was employed in 1983. The basic unit of excavation remained unchanged, that is, a 2 m^2 unit partitioned into 1 m^2 quadrants and 50 cm^2 subquadrants (Brink et al. 1985:21). All units were primarily excavated using trowels and proceeded by arbitrary 10 cm levels. In many instances, the density of bone and fire broken rock required that a single 10 cm level be excavated as a series of layers. This was necessitated given our wish to record spatial distribution data. Every layer and level of each unit was drawn in plan view using separate forms for fire broken rock and faunal remains. These diagrams were drawn using a 1:10 scale with the relative size and shape of the FBR recorded impressionistically and the provenience and type of bone element recorded according to an alphabetic code. Flaked and ground stone artifacts were not piece-plotted, but rather were bagged by 50 cm subquad and 10 cm level. This is a continuation of the 1983 lithic recovery strategy.

It was apparent from our previous field excavations that the density of remains would not permit the drawing of every piece of FBR nor coding every bone fragment. Such maps would ultimately prove exceedingly complex and would effectively obscure the salient characteristics of the rock and bone distributions. It was therefore decided that some minimal criteria be met before the stone and bone remains were recorded, drawn and bagged for further analysis.

In the case of FBR, it was requisite that the fragment be approximately 5 cm or greater in maximum dimension for it to be recorded on the diagram. The basic shape of the fragment was portrayed, but the accuracy of this depiction varied greatly with individual recorders. The material type was recorded simply as either sandstone or non-sandstone, thus recording the use of local Paskapoo sandstone versus imported rock.

The identification of the faunal remains was greatly assisted through a review of in situ remains by a faunal analyst familiar with bison bone. While the crew was provided with a rudimentary field identification manual for bison elements, there always seemed to be some specimens that eluded our most concerted communal scrutiny. It was also evident that the removal of badly deteriorated elements would effectively negate any later opportunity to identify the remains, as transport and handling would result in the specimen being reduced to many unidentifiable portions. Such specimens were identified in situ. In the instances where an infield identification proved impractical, the bone was foil wrapped and transported to an on-site field laboratory containing several comparative faunal specimens, including bison and a variety of carnivores. This procedure greatly improved our ability to identify the faunal remains at Head-Smashed-In, but it did not provide a means for dealing with the hundreds of thousands of small unidentifiable bone fragments and tooth enamel portions that are found throughout the camp and processing site deposits.

During the previous field season, all bone and tooth enamel fragments were tediously recovered from the screened matrix. This resulted in a huge assemblage of small fragments, all of which were non-identifiable below the level of order (i.e., mammalian long bone fragment, rib fragment, tooth enamel fragment, burnt bone fragment [see Klein and Cruz-Uribe 1984:17-21]). Despite the long hours required to collect, catalogue and analyse these thousands of non-identifiable bone and tooth portions, there was very little information regarding subsistence activities or butchering practices that could be wrung from these remains. Based on our detailed analysis of the 1983 assemblage, it was determined that most if not all of the non-identifiable fragments could have been the result of a variety of post-depositional agencies such as weathering and trampling, rather than a result of any cultural activities such as bone processing (Brink et al. 1985:179). Given the results of our 1983 study, there seemed little point in tediously gathering yet another vast assemblage of non-identifiable bone fragments, and it was therefore decided that the 1984 faunal recovery techniques should be altered from that employed in 1983.

Faunal remains which were classifiable as non-diagnostic unidentifiable long bone fragments, rib fragments, tooth portions and burnt bone portions were neither recorded or retained, and were deposited on the backdirt piles. In adopting this methodology, we ensured that all the bone recovered from the camp and processing site deposits was identifiable below the level of genus, but this also meant that we ran the risk of losing data by virtue of selectively discarding portions of the faunal assemblage. We were confident that the discarded bone was of no importance to our interpretation of the Head-Smashed-In faunal assemblage, but at the same time we felt an obligation to determine the magnitude of this recovery bias. It was therefore decided that the backdirt piles from selected excavation units would be maintained on a mutually exclusive basis, and the matrix sampled following completion of the excavation. The results of this sampling exercise are presented elsewhere in this report. The only exception to this faunal recovery strategy occurred during the excavation of archaeological features.

A variety of archaeological features were encountered in the block excavation unit. These included hearths, natural and man-made pit depressions, bone and FBR concentrations and bone uprights. The majority of features are not discernable until the overlying mantle of bone and

FBR is removed (i.e., 0-10 cm), and it is therefore likely that the upper portions of some features went unrecorded. Once the perimeter of a feature was defined, it was photographed and the dimensions and characteristics of the feature recorded. The feature was then profiled, usually in accordance with its longest axis, additional photographs taken and the profile drawn. The profile matrix was retained for subsequent flotation and fine screening using 2 mm mesh. All of the artifactual and faunal remains from the float and fine screen fractions were retained for subsequent analysis. It was postulated that these remains would assist in delineating the kinds of activities that were associated with the use of the particular feature under scrutiny.

In order to expedite cataloguing and analysis of the Head-Smashed-In artifact and faunal assemblages, a field laboratory was established on site for the duration of the 1984 field season. This lab facility was housed in a trailer which contained the comparative faunal specimens as well as basic lab equipment including microscopes, weigh scales, size squares and a variety of forms and coding manuals. All faunal remains were catalogued in the field and field records were transferred to computer coding sheets. The details of the faunal coding procedure utilized have been presented in an earlier report (Brink et al. 1985:368), but basically involved the determination of species, element, fragment classification, alterations and specimen weight. This procedure ensured that delicate specimens could be fully analysed prior to transport and significantly reduced the post-field lab requirements. Only one change was made to this faunal coding procedure in 1984, and this involved the use of a simplified procedure for the classification of element portions. The details of this coding system are presented in the faunal analysis sections.

Lithic remains were not catalogued in the field but were sorted by excavation unit for subsequent transport to the Archaeological Survey of Alberta lab facility. The other artifact assemblages were too small to warrant field processing.

The FBR recovered from the block excavation constituted a substantial volume of material weighing several hundred kilos and one which we determined would be best processed on site. The FBR level bags were transferred to the field lab and the contents subjected to a variety of analytical assessments. Although a variety of material types were employed as boiling stones at Head-Smashed-In, including the local sandstone and imported quartzites and limestones, the lithology was simply recorded as either sandstone or non-sandstone, the former always being the local Paskapoo sandstone. The fragments were sorted into size categories using a 5 cm increment grid square, and the weights and counts of fragments in the various size categories recorded. Following this assessment, the assemblage of FBR was discarded off-site. In some cases, the inspection of the assemblage revealed evidence of pecked and ground surfaces indicating that the FBR fragment was once part of a ground stone tool. Although a number of these artifacts were recognized and retained, it is quite likely that some went unrecognized and unrecorded.

Matrix samples from pit features and backdirt sampling were transported to a field camp where they were processed in a flotation device. The particulars of the flotation device employed have been detailed elsewhere (Brink et al. 1985; Wright and Ball 1983).

ANALYSIS OF MATERIAL REMAINS

Introduction

This section provides the results of the analysis of artifactual remains from excavation units in the camp and processing site at Head-Smashed-In; a separate section is devoted to an analysis of the spatial distribution of selected classes of remains recovered from some of these units. It needs to be stressed at the outset that the remains analysed herein are the end product of many episodes of occupation and clearly represent a mixed assemblage. This is true despite our intentional selection of a "peripheral" area of the processing site for excavation. That said, it is nevertheless possible that some aspects of the assemblage may retain at least a vestige of their contextual relationships, and it is these which we endeavour to elucidate in the spatial analysis of the material remains. The analysis of the subsurface feature assemblage from the block excavation is felt to be particularly informative in this regard given that they are less susceptible to post-depositional dislocation than are surficially deposited remains. In analysing these data, we are specifically concerned with the identification and reconstruction of the kinds of activities that were conducted in the camp and processing area of Head-Smashed-In. Because of the nature of our data and the omnipresent evidence of post-depositional alterations to our assemblage, these reconstructions have been assembled in a state of cautious optimism. The presentation of these constructs is therefore more in the line of a series of working hypotheses regarding activity patterning rather than definition of discrete events which can rarely be discerned at Head-Smashed-In.

Features

A total of 23 subsurface features and a single rock ring feature were recorded in the course of the 1984 excavation of the camp and processing site. The analysis of the subsurface features follows a standardized format, and they are presented in the order in which they were discovered. This analysis is primarily descriptive, and extensive use of plan and profile drawings as well as photographs is evident throughout the text. Additional graphic representations are provided that detail the contents of the features. These include identifiable bison bone elements, non-identified mammal bone fragments and FBR assemblages.

The identified bison elements are presented in two formats: the first documents the representation of the bison skeleton according to the cranial (C), axial (Ax) and appendicular (Ap) elements; the second focusses on the appendicular assemblage noting the occurrence of forelimb (F), carpals (C), rear limb (R), tarsals (T), and phalanges (P). The counts are based on NISP calculations in all instances. The motivation behind this presentation was to identify which portions of the bison carcass are represented in the various features with a mind toward identifying those particular features that may have been associated with specific processing activities. This follows from our working assumption that the bulk of the activities represented by the camp and processing site deposits involved the secondary butchering and processing of bison carcasses and that many of these were probably quarters (i.e., appendicular elements).

The non-identifiable fragments are quantified according to percentage weight based on five screen fractions. These fractions provide a measure of the range of fragment sizes present and their relative abundance

(Brink et al. 1985). The fractions are based on standard sieve sizes as follows: 31.5, 16.0, 11.2, 6.3, and 3.35 mm. The size of the bone fragments present in the feature fill can be useful when attempting to determine what kinds of bone processing may be in evidence, such as relatively large fragments resulting from marrow extraction, or small fragments resulting from bone breakage for purposes of grease extraction by bone boiling. The precise identification of these activities based solely on bone fragmentation classes is fraught with interpretational difficulties. Not only are these processing events unlikely to have been mutually exclusive, but there are other taphonomic agencies which can fragment bone and such fragments could infiltrate the feature matrices. When these kinds of bone processing activities are identified at Head-Smashed-In, it is based on multiple lines of evidence (Vehik 1977).

The FBR assemblage is categorized according to material type and number of items within discrete size classifications (0-5, 5-10, 10-15, 15-20 and 20 cm or larger). These data assist in the discrimination of features that may have been employed in heating stone and use of stone boiling as opposed to stone roasting. All of the features discussed are illustrated in plan view in Figure 12.

Tipi rock ring

The arrangement of six large sandstone rocks located in the north portion of the block excavation provided the impetus for the location of the initial 2 m^2 unit (Figure 12). We noted during the course of our surface reconnaissance that much of the camp and processing site is littered with large sandstone rocks. Presumably, these rocks originated as cliff topple, which had been subsequently conveyed to the flats below the cliff as a product of slope wash. We assume this process has been in constant operation at Head-Smashed-In and would have provided a ready supply of suitably sized rock fragments for the purposes of weighting down tipi cover flaps. At the same time, it is evident that there are relatively few well-preserved ring structures at Head-Smashed-In, suggesting that the use of rocks to secure tent flaps was not the convention at Head-Smashed-In or, alternatively, that tent flaps did not need to be secured. While bone pegs are not prolific at Head-Smashed-In, their presence suggests that bone, and possibly wooden stakes, were

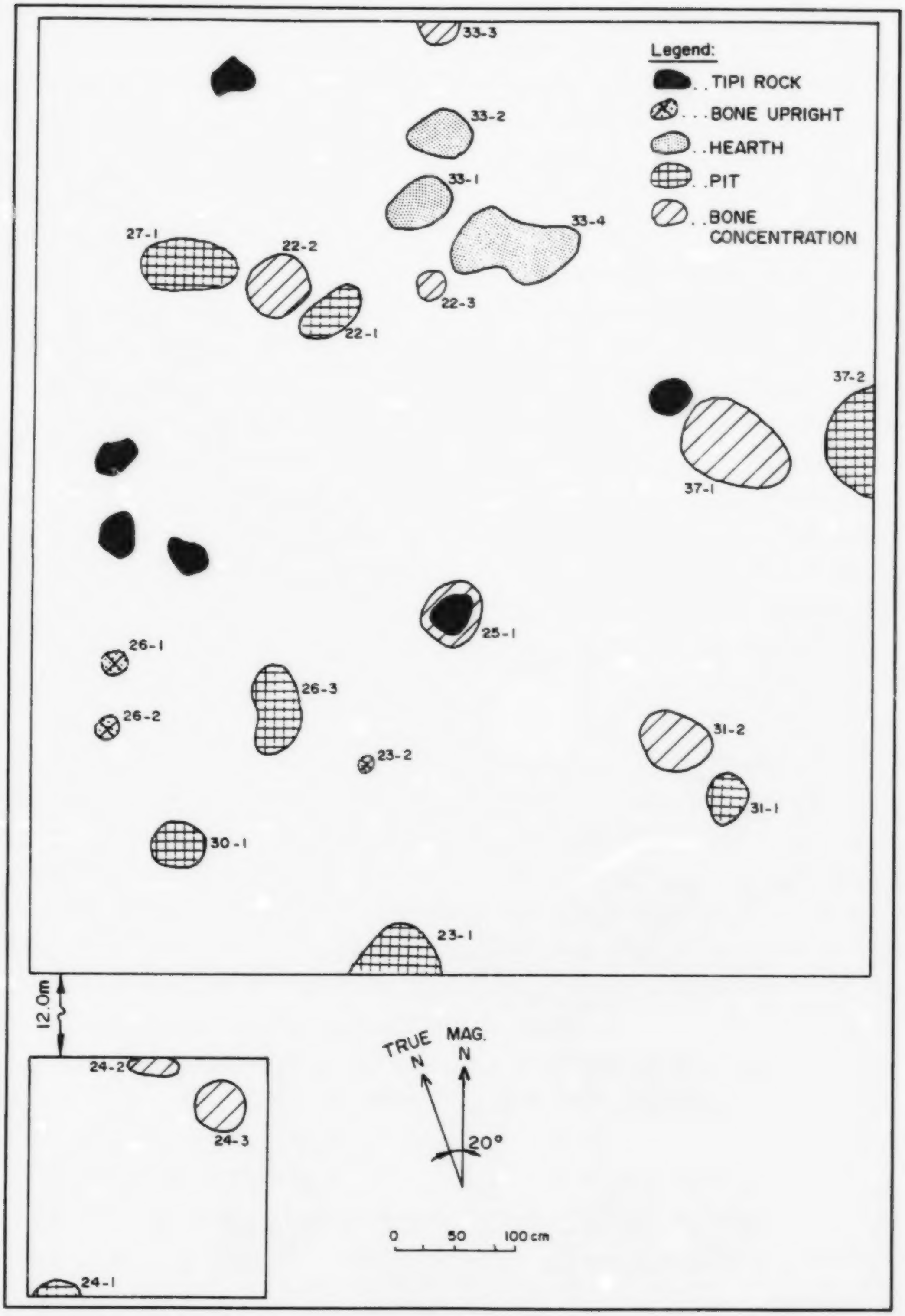
33-3
Legend:
. . TIPI ROCK
. . . BONE UPRIGHT
. . HEARTH
. . PIT
. . BONE CONCENTRATION
33-2
33-1
33-4
27-1
22-2
22-3
22-1
37-2
37-1
25-1
26-1
26-3
26-2
23-2
31-2
31-1
30-1
23-1
12.0m
24-2
24-3
24-1
TRUE N
MAG. N
20°
0
50
100cm

Figure 12. Feature distribution within block excavation and Unit 24, Area 2.

likely used to secure tent flaps and to anchor structures. Weather permitting, it may not have been necessary to anchor tent flaps, but the persistent winds at HSI would seem to make some form of restraining device requisite. It is also possible that suitable sized rock was recycled from existing rings during seasonal occupations of the site, thus complicating the identification of individual ring structures.

The area defined by the ring measures 4.75 m in diameter. The majority of the rocks occur along the southwestern perimeter of the ring, which is coincident with the prevailing winds. There are no surficial features associated with this ring, such as a central hearth depression or rock concentration, and all but one of the ring rocks are deeply buried. The fact that the rocks are deeply buried may be taken as tenuous evidence of the age of this structure. The depositional environment at Head-Smashed-In is one of extremely slow soil accumulation, and deeply buried rocks are therefore assumed to be indicative of an earlier occupation than would be the case with surficially deposited specimens. Little else can be said regarding this possible structure at this time. The feature analyses which follow, and subsequent consideration of the spatial distribution of material remains, will provide further comparative evidence to assist in the evaluation of this possible tipi ring.

Feature 22-1

This subsurface pit was overlain by a dense deposit of FBR which had to be removed before the boundaries of the feature could be defined. It is likely that some of this mass of FBR was actually incorporated within the upper matrices of the pit, but the extent of this association could not be determined. The plan shape of the feature appeared at the 10 cm level as a dark 60x40 cm oval stain containing several fragments of FBR (Figure 13). The feature fill appeared to be primarily organic rich sediment containing charcoal flecks and small scattered pieces of calcined and non-burnt bone. There was no evidence of in situ heating and the perimeter of the feature marked a sharp boundary against the surrounding sterile subsoil.

The pit was profiled along an east-west axis, and the fill was removed to expose the original shape of the pit. This profile revealed

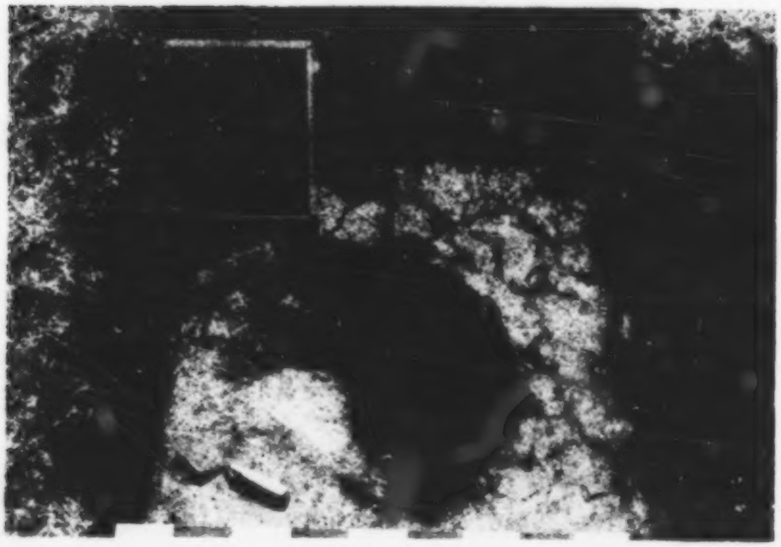

Figure 13. Plan view of feature 22-1.

no evidence of sequential episodes of pit infilling, or any lensing of the deposits. Additional fragments of FBR were excavated from the profile, as well as several pieces of bone, but only one of these was identifiable, that being a bison phalange. The profile indicated that the pit was asymmetrical, and excavation of the remaining pit fill confirmed this observation. In fact, it revealed that the southwest end and west side of the pit define the pit's maximum depth and that the pit floor rises up towards the east and north-east. Such a configuration would result if the original excavator of the pit had been situated in the northeast corner of the unit. Given the compacted nature of the Head-Smashed-In sediments, such a feature could not have been dug by hand. Tempered steel shovel blades have been known to bend when applied to the HSI substrate. Even equipped with a digging stick, it would require that the ground be softened either by seasonal conditions or by the application of water. The extreme aridity of the Head-Smashed-In area is attested to by the dessication cracks which extend 30 cm into the subsoil, and soil fissures reaching upwards of half a metre were recorded during the drought era of the 1930s (Edward Yellowhorn, pers. comm. 1984).

The bone fragments recovered from the pit fill were few in number and can not be considered characteristic of any particular activity.

Similarly, the FBR assemblage was insignificant (n=6) and composed entirely of non-sandstone materials (Figure 14). The only notable finding within the pit fill was a projectile point base which is typologically consistent with McKean points (see Figure 70k). There was also a small amount of debitage recovered during the fine screening of the feature fill. Sufficient wood charcoal was recovered from the float fraction for C-14 dating, and this returned an assay of 2710±150 years:760 B.C. (AECV 60c) (Table 2).

It is difficult to surmise what function this pit originally served, for neither the content nor the morphology of the feature provide substantive clues. The lack of evidence for direct heating eliminates the possibility of a hearth or roasting pit function, and the small size of the pit, limited quantities of FBR, and inconsequential bone assemblage appear to discount a boiling pit function. It seems most likely that the contents of this pit actually have little to do with the function it originally served and that these remains represent the infiltration of site surface debris. The fact that this feature

Table 2. C-14 samples, Area 2.

Lab	Provenience	Material	Date
AECV 59c	AREA 2 UNIT 31 FEATURE 1	(W)	470±110
AECV 60c	AREA 2 UNIT 22 FEATURE 1	(W)	2710±150
AECV 61c	AREA 2 UNIT 33 FEATURE 1	(W)	530±140
AECV 64c	AREA 2 UNIT 30 FEATURE 1	(B)	190±80[+]
AECV 65c	AREA 2 UNIT 27 FEATURE 1	(B)	470±90[+]
AECV 66c	AREA 2 UNIT 26 FEATURE 1	(B)	1000±500[+]
AECV 67c	AREA 2 UNIT 26 FEATURE 3	(B)	860±380[+]
AECV 119c	AREA 2 UNIT 37 FEATURE 2	(W)	680±110

[+] Samples submitted for reanalysis.

(W) Wood charcoal

(B) Bison bone

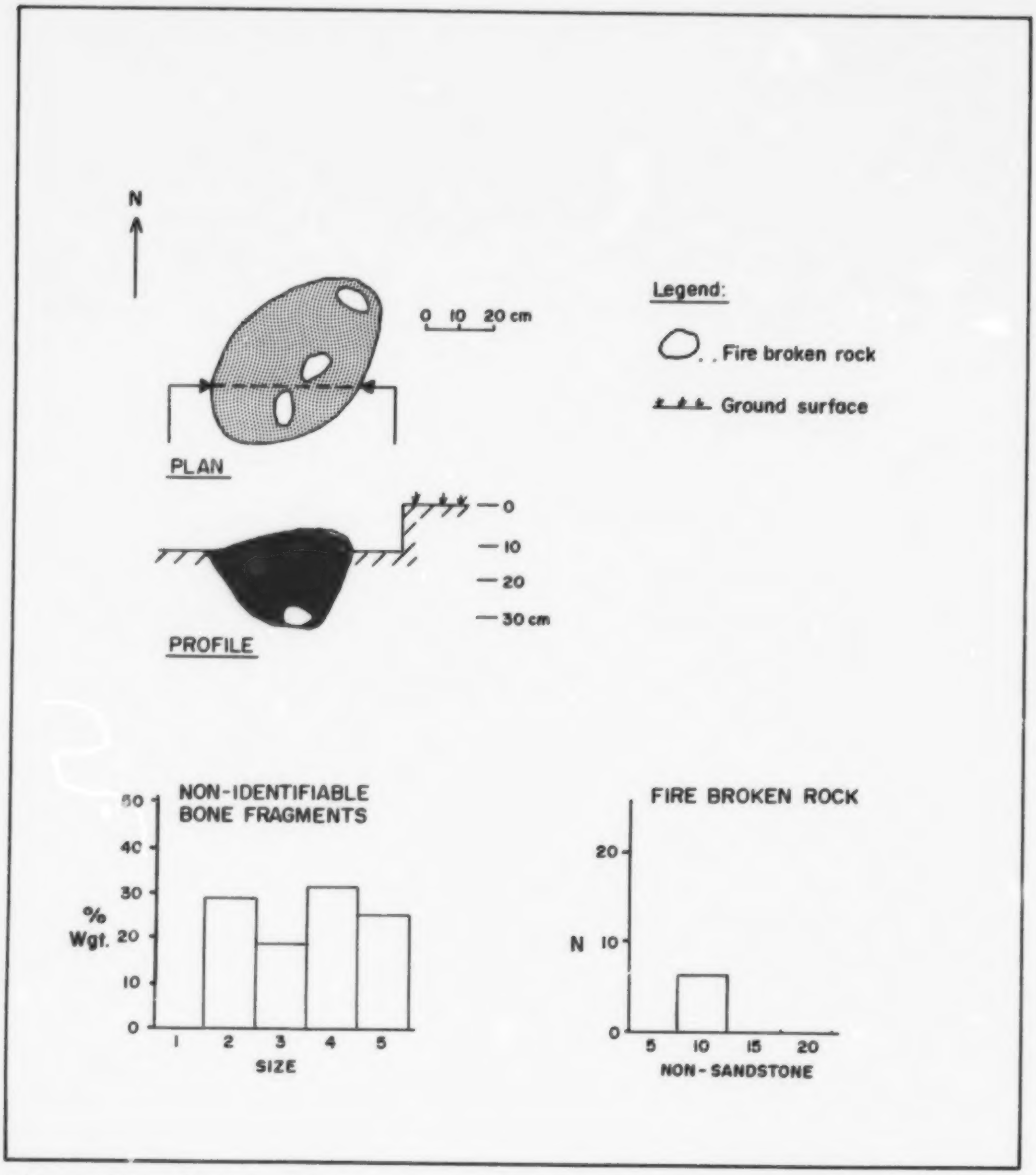
N
Legend:
Fire broken rock
Ground surface
0 10 20 cm
PLAN
PROFILE
0
10
20
30 cm
NON-IDENTIFIABLE BONE FRAGMENTS
% Wgt.
50
40
30
20
10
0
1
2
3
4
5
SIZE
FIRE BROKEN ROCK
N
20
10
0
5
10
15
20
NON-SANDSTONE

Figure 14. Feature 22-1 plan, profile and content summary.

represents a probable McKean occupation is significant, for this culture horizon marker is absent in the kill site deposits (Reeves 1978). Unfortunately, we will probably never know the purpose for which this feature was constructed.

Feature 22-2

This 50 cm diameter feature was not recognized as such during the course of the excavation, and only became apparent upon a review of the bone distribution plots. There was no pit depression associated with these elements, and the delineation of the feature perimeter was largely based on the diminishing density of bone elements. This kind of feature, designated herein as a bone concentration, is particularly difficult to recognize at Head-Smashed-In, given that much of the upper site deposit is composed of thousands of bone element portions. In the final analysis, it is not the density of the bone remains per se that defines bone concentrations but rather the association of elements represented.

In the preamble to this section, we suggested that the activities conducted in the camp and processing site would be manifest in the kinds of remains contained within the archaeological record. We envisioned, for example, that specific episodes of butchering and processing would create discrete concentrations of bone element portions; such activities would include marrow extraction and bone degreasing. Presumably, these kinds of tasks would have been undertaken in an "assembly line-like" fashion, involving the gathering and processing of many bone elements within a specific area (see Binford 1978). In the case of marrow extraction activities,we assume that leg bones, particularly the larger limb elements, would be selected for processing. Once the marrow was removed, the articular ends may either have been discarded, or possibly further processed for the removal of grease contained in the ends of these large limb bones. In either eventuality, a very characteristic residue of bone would result, which, for marrow processing, would involve a concentration of appendicular elements and numerous mid-shaft bone fragments.

This is exactly the pattern we find in the case of feature 22-2, for it contained mostly appendicular remains, the majority of which were limb bone portions, notably the forelimb elements. A breakdown of the bone element portions recovered from this feature is presented in Figure 15. The predominance of appendicular remains is consistent with the residue resultant from secondary butchering practices. The element portions represented included all proximal portions, suggesting perhaps that the remains are the result of marrow extraction and not bone degreasing. The evidence of bone degreasing should be manifest by the absence of these large articular ends as these would be the preferred grease bones (Binford 1978; Brink et al. 1985).

The location of this bone concentration is also significant for it is adjacent to the former feature and quite close to another large pit feature yet to be discussed. It was initially thought that the proximity of features 22-1 and 22-2 provided a clue to the function of 22-1, but the early date associated with the pit presents a problem. How could bone deposited in the upper 10 cm of the site be coeval with a 2700 year old feature? The presence of another pit feature immediately to the west of the bone concentration provides a potential association, and one that is much more likely to be contemporaneous with the activity that produced the bone residues in feature 22-2.

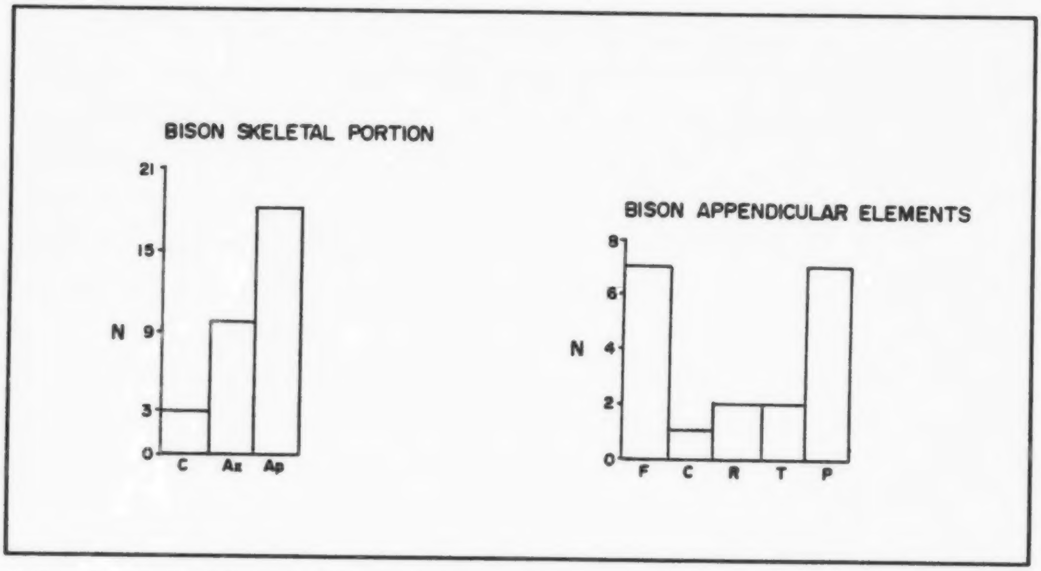

Figure 15. Feature 22-2 content summary.

Feature 22-3

This feature is defined on the basis of a small pit depression containing a tight cluster of appendicular bone elements (Figure 16). It is designated as a bone concentration rather than a pit feature based on the belief that the bone is actually occupying a depression that resulted from rodent disturbance. There is abundant evidence of such burrow disturbance throughout the Head-Smashed-In deposit , and it is likely that some of these natural "pit-like" depressions may have been used as expedient containers (see Figure 53). This is based on the observation that it is easier to exploit a natural concavity in the land surface than to excavate the compact, undisturbed substrate.

The depression is oval in planform, measuring 40 by 30 cm and attaining a maximum depth of 20 cm below surface (Figure 16). The concentration of bison elements is clearly evident in plan view (Figure 17) and primarily composed of rear limb elements, particularly tarsals. The feature matrix contained dark sediments interspersed with burnt and non-burnt bone fragments and several small fragments of clam shell; no FBR was recovered. The analysis of the non-identifiable bone fragments revealed that they were primarily small fragments of size classes 6.3 and 3.35 mm.

The composition of the bone assemblage is somewhat enigmatic given our understanding of bone processing activities; that is, why would tarsal elements be processed? Given their compact nature and small size, they would be unlikely candidates for bone processing and, in any event, the elements are primarily whole and show no evidence of reduction for bone grease extraction. It was speculated that the assemblage of fragmented bone might prove useful in reconstructing the activities associated with the use of this feature, but it appears most likely that these remains are simply representative of fragments that have entered the depression as pit fill. In the final analysis, no specific function can be ascribed to this bone concentration.

Feature 23-1

This large pit depression feature is located adjacent to the south wall of the block excavation unit. The portion of the feature extending outside the unit was not excavated. As such, we only have a partial plan

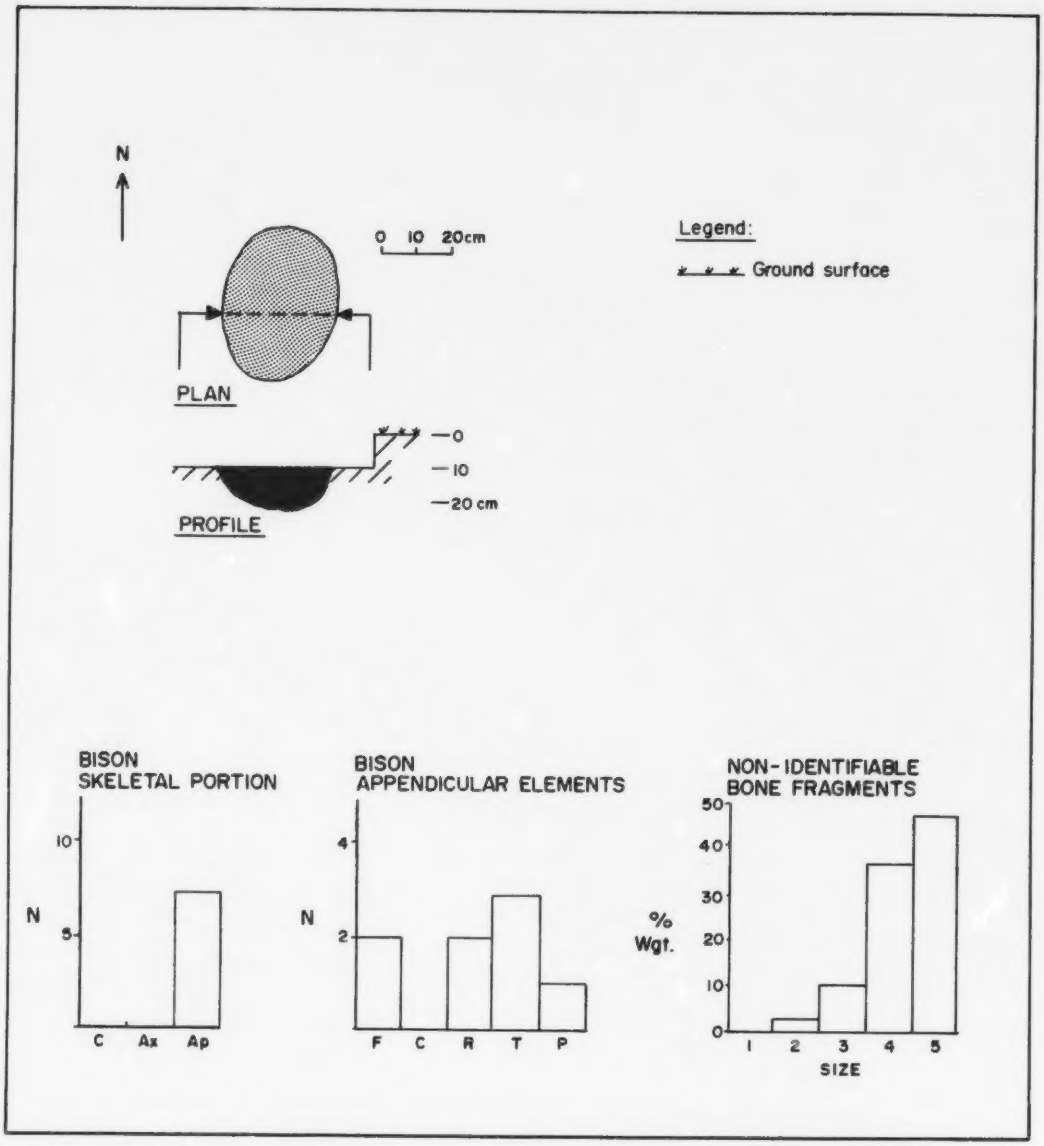

Figure 16. Feature 22-3 plan, profile and content summary.

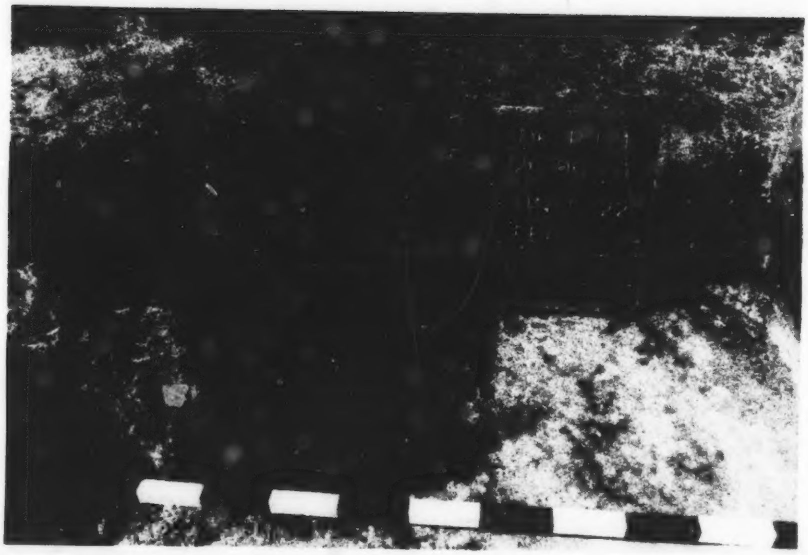

Figure 17. Plan view of feature 22-3.

drawing of this irregularly shaped pit which may have been upwards of 75 cm in diameter (Figure 18). The profile of the depression revealed a basal deposit of oxidized sediment that is overlain by a 5 cm thick ash lense. The remainder of the feature fill is composed of dark sediments containing abundant bone elements and FBR portions (Figure 19).

The elements were primarily appendicular remains, predominantly tarsals and phalanges. The non-identifiable bone assemblage contained a significant number of large sized long bone fragments and relatively few small sized bone portions. The FBR assemblage is almost entirely composed of non-sandstone materials. These were primarily large pieces, 10 cm or greater in maximum dimension (Figure 18).

Although this pit feature was not completely excavated, there seems little reason to doubt that it was used as a roasting pit facility. The clear evidence of in situ heating and ash deposits is consistent with ethnographic descriptions of pits that were used to cook both vegetal foods (James 1905; Lowie 1954; Turney-High 1933; Wissler 1910) and bison meat portions (Turney-High 1937; Wissler 1910). Similar kinds of pit features have also been described from a number of plains archaeological sites (Brown 1980; Congram 1978; Greiser et al. 1983; Mulloy 1954; Munson

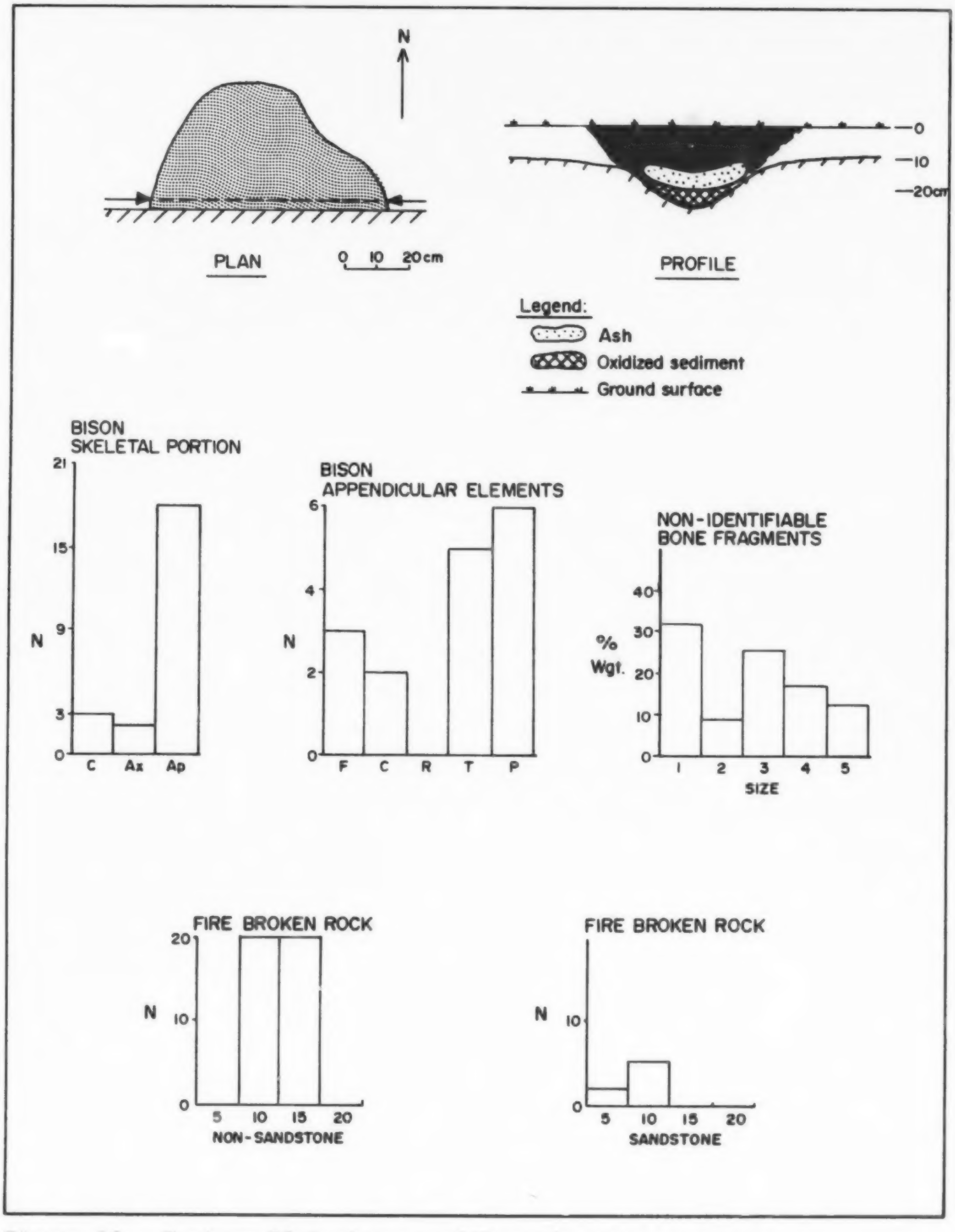

Figure 18. Feature 23-1 plan, profile and content summary.

Figure 19. Profile view of feature 23-1.

1984), but a variety of activities including the heating of rock for stone boiling may be represented by some of these features.

The nature of the remains found within 23-1 is suggestive of secondarily deposited, but associated debris from the site surface rather than intact refuse from a specific cooking episode (cf. Frison 1973). That is, we would not expect the roasting of tarsal elements, given the minimal meat yields involved, but it is quite reasonable that such resilient bone elements would be found dispersed over the campsite surface and could therefore have easily been incorporated into the pit as secondary feature fill.

Feature 23-2

This feature consists of a single bone element that appears to have been driven into the ground and presumably served as an anchoring device of some type (Figure 20). The element is a thoracic spine, and the distal end has been purposely sharpened; however, the proximal end is too poorly preserved to enable comment on the presence or absence of battering (see section on worked bone). This kind of feature has been termed a bone peg by some authors (Heitzmann 1983; Munson 1984), and they have been interpreted to be the remains of anchoring devices for tipi covers, or for securing the perimeter of a hide-lined or covered pit (Keyser 1979; Paget 1909; Skinner 1914; Wilson 1977). Very few of these pegs have been excavated in situ. While it is possible that many may have been dislodged in the process of site abandonment (Wilson 1977:192), it is curious that more have not been found to date. Presumably, the pegs were used to augment the weighting down of the shelter margins with large stones or as a replacement in the instance where suitable sized stone is not available. It certainly appears

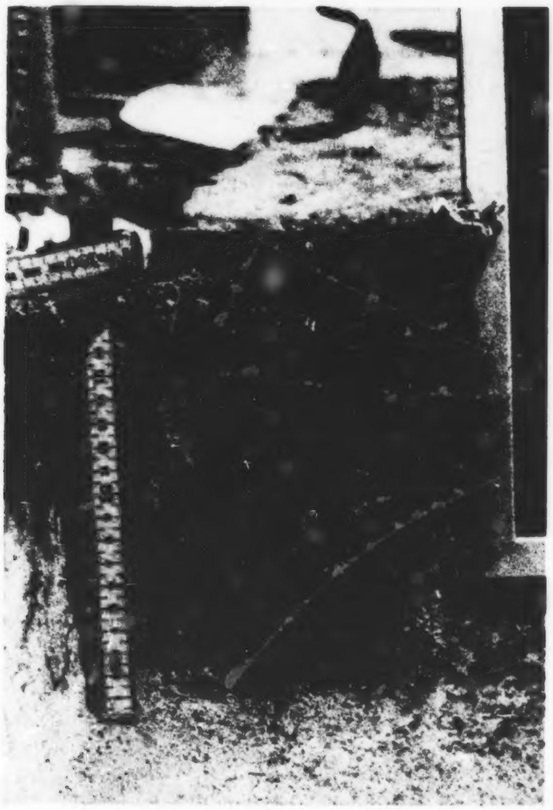

Figure 20. Profile view of feature 23-2.

evident that wooden stakes were popularly employed as pegs at the time of contact (Heitzmann 1983:109, Figure 16; Dyck 1977:321-322, Figures 30 and 31), and they are preserved in a few prehistoric contexts (Frison 1968a).

A major difficulty encountered in the identification of bone pegs is ensuring that the bone has been purposefully modified and that the context is secure. The potential for the incorporation of elements into the vertical matrices of abandoned rodent burrows is omnipresent at most plains archaeological sites including Head-Smashed-In (cf. Brink et al. 1985:232). It is also evident that bone alterations created as by-products of secondary butchering and bone processing could, on the basis of a cursory examination, be misconstrued as evidence of peg manufacture. Presumably, any feature identified as a bone peg should exhibit clear evidence of purposeful shaping, insertion into non-disturbed substrate and immediate association with other features (i.e., pit or tipi ring). Fortunately, the bone peg from Head-Smashed-In satisfies these criteria, assuming of course that the partial ring structure and the bone peg are associated. It may be significant that the peg is located approximately 1 m to the south of this ring and that the prevailing winds at Head-Smashed-In are also from the south. Anyone who has visited the Head-Smashed-In site on a day of normal wind velocity can appreciate the formidable forces to which shelters would be exposed on the more "breezy" days and the necessity of subsidiary anchoring strategies (Finnigan 1982:29).

Feature 24-1

This pit feature is located along the southern margin of this isolated excavation unit, and it appears that a large portion of this feature extends beyond the limits of the excavation (see Figure 12). The profile of this pit feature reveals a width of 45 cm and depth of 30 cm, but these should be interpreted as minimum values only. Because only a small portion of the pit was sampled, no comment is possible regarding the few remains recovered and no bulk sediment sample was obtained for detailed evaluations.

The pit profile revealed something of the structure of this feature, specifically, a basal deposit of ash and charcoal overlain by humic sediments containing ash lenses and a final capping of dark humic sediment (Figure 21). Unlike the evidence found in Feature 23-1, there is no indication of in situ heating of the sediments surrounding 24-1. The charcoal and ash deposits could be explained if the base of 24-1 had been lined with vegetal matter, filled with hot rock and a food bundle, and then covered with earth and a fire kindled on top. Such roasting pits are unlikely to have conveyed enough heat to oxidize the surrounding sediments, and the reducing atmosphere would ensure that not all the fuel would be consumed, hence the charcoal lense. Obviously, the cooked food and rock were removed from the pit and the expelled ash and sediment could then infiltrate the emptied depression. Analogues for such features can be found in a variety of plains ethnographies and are noted as having been used for the cooking of both meat and legumes (cf. Turney-High 1933; Wissler 1910). At Head-Smashed-In, it is likely that such pits were exclusively devoted to the task of cooking meat portions in the absence of any locally abundant resource of legumes.

Feature 24-2

This concentration of bone elements (Figure 22) constitutes the best preserved "butchering unit" encountered during the course of the 1984

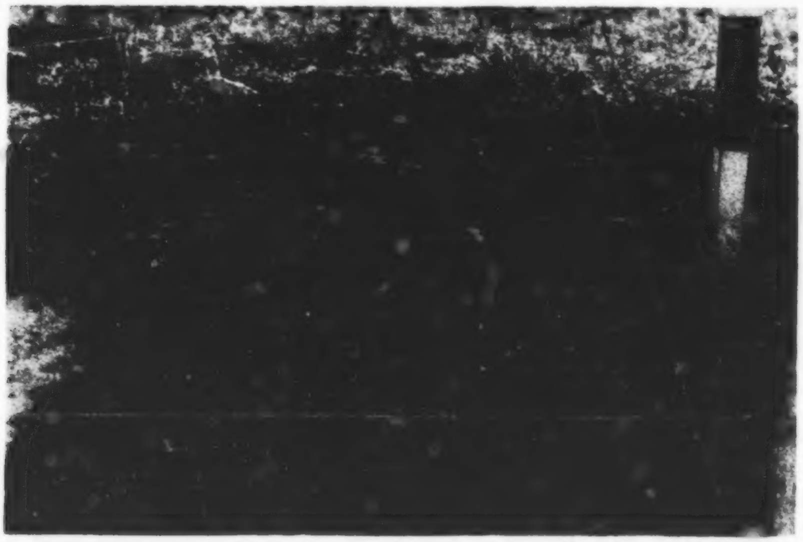

Figure 21. Profile view of feature 24-1.

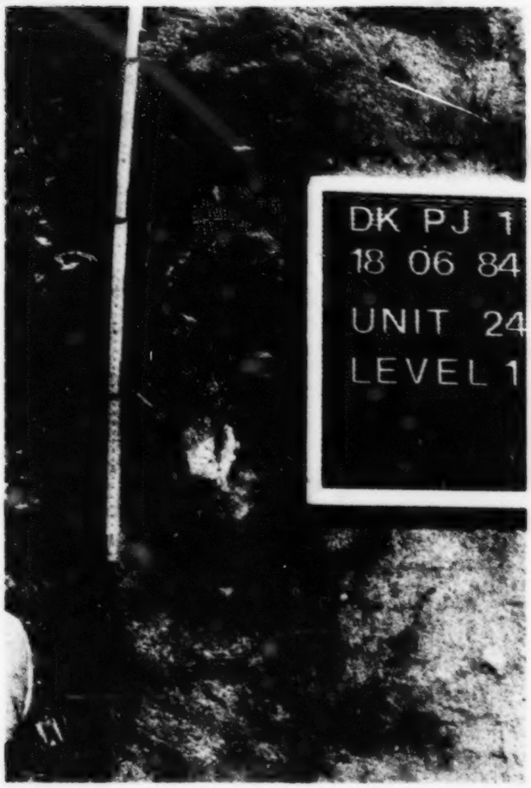

Figure 22. Plan view of feature 24-2.

excavations. The term butchering unit implies that the assemblage of bone represented has been processed in one episode of butchering and therefore represents a discrete activity. The concentration of bone is located parallel to the north margin of unit 24, and most of a forelimb is represented. This included the proximal end of the humerus, the distal and proximal articular ends of the metacarpal and the complete assemblage of phalanges and sesamoids. All the elements are in correct anatomical position, but only the distal metacarpal, phalange and sesamoid grouping remained articulated. A summary of the elements represented is presented in Figure 23.

It is notable that neither the radius nor ulna is present and that only one carpal bone was recovered, suggesting that the complete limb was broken below the mid-shaft of the humerus and above the distal end of the metacarpal and taken elsewhere for further processing. The distal

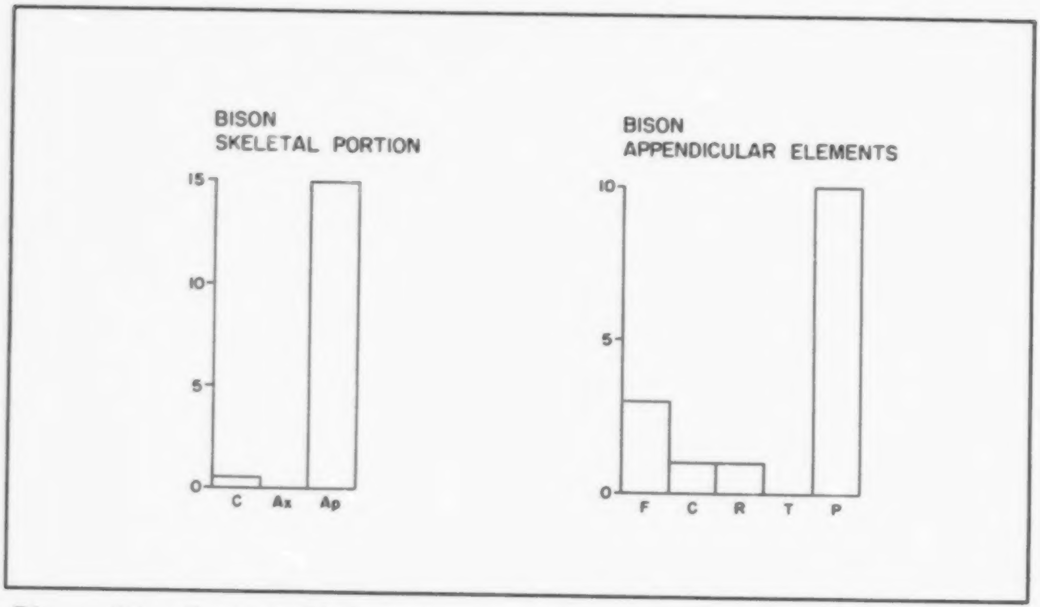

Figure 23. Feature 24-2 content summary.

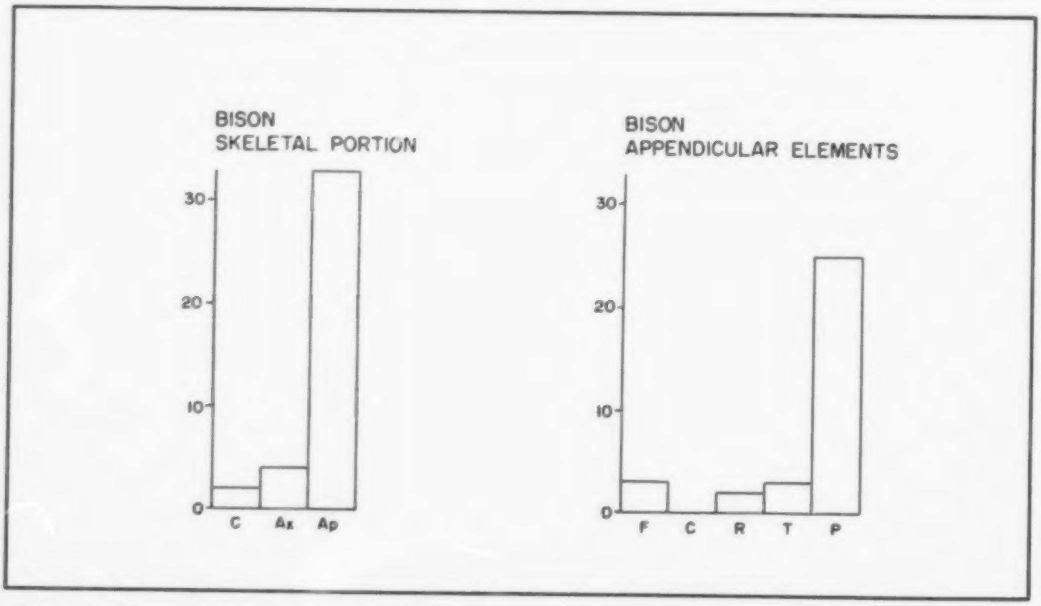

Figure 24. Feature 24-3 content summary.

portion of a tibia was also present in the bone concentration but the association is thought to be fortuitous.

Feature 24-3

Yet another concentration of bone elements was recognized less than 50 cm from the previous feature, but these do not constitute a single butchering unit. The concentration was not recognized as a feature during the course of the excavation and no pit or stain was associated with these remains. The majority of the elements present are derived from the appendicular skeleton, and most of these are the extreme lower limb elements, that is, distal to the metapodials (Figure 24).

This large assemblage of phalanges and sesamoids suggests the presence of localized butchering activities whereby the lower section of the limb was removed from that which contained the major meat and marrow yielding portions. The minimal representation of carpal and tarsal elements combined with a few articular ends of the major limb bones would be a logical result of such activities and the nearby evidence of exactly this kind of processing (Feature 24-2) adds further support to this interpretation. This concentration of bone does not extend to the eastern limit of the excavation unit, but it is speculated that a large pit used in processing these upper limb elements may be found in this area.

Feature 25-1

This was the only feature recorded in unit 25, and its composition is a curious one. The feature consists of a diverse assemblage of bison bone elements and FBR in a compact deposit beneath one of the tipi ring rocks. The composition of the faunal inventory is detailed in Figure 25 and some anomalies are readily apparent. Although appendicular elements constitute the most numerous element class, there is a significant representation of cranial and axial remains that has yet to be found in other features. Even the composition of the appendicular remains runs counter to previous findings in that phalanges and sesamoids are not the dominant element class. Despite the fact that a large assemblage of FBR was found in association with the faunal remains, there is no obvious pattern to these rocks and no evidence of localized heating. Reviewing

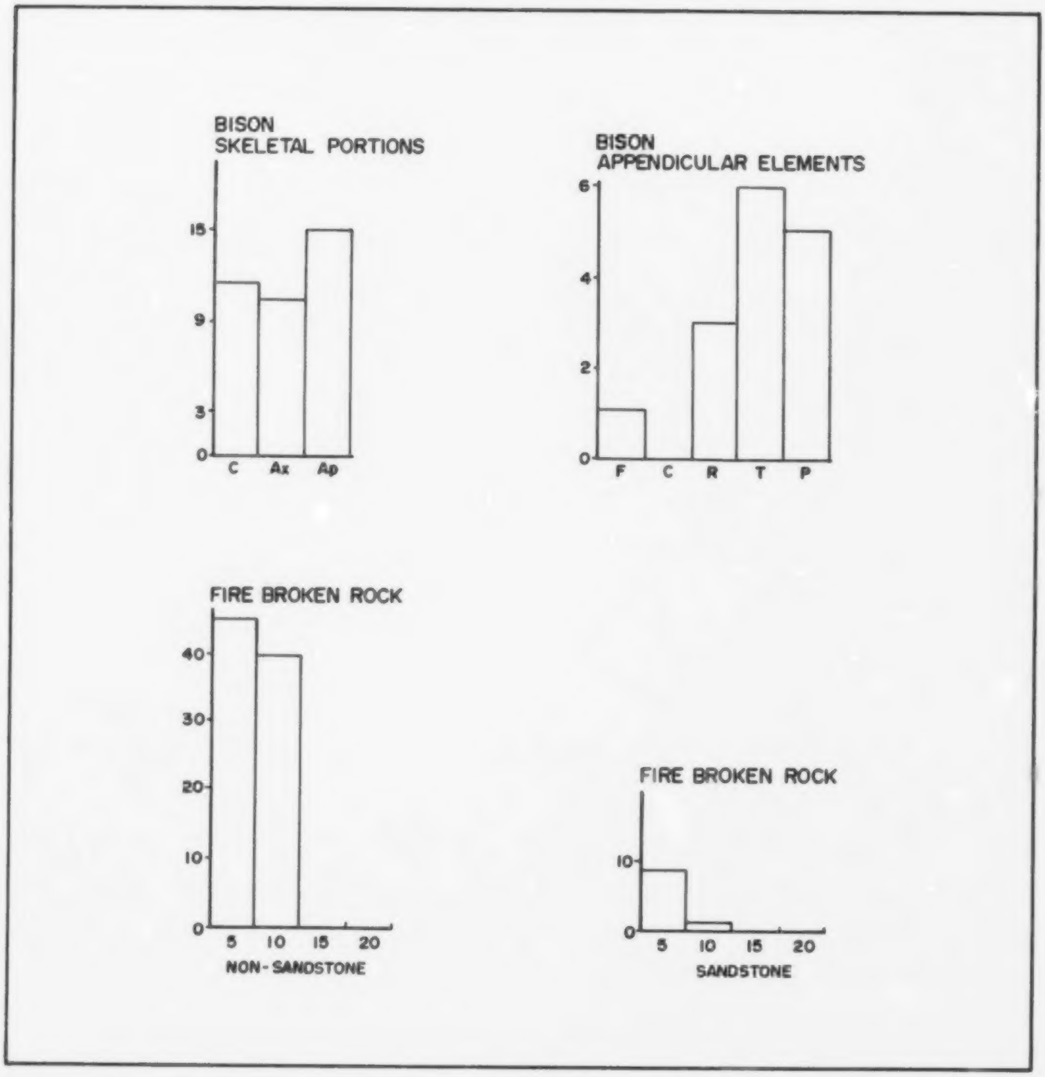

Figure 25. Feature 25-1 content summary.

the faunal assemblage failed to discern any obvious butchering marks or clusters of elements that might legitimately be expected to occur if the remains represented a discrete processing activity. It appears most likely that this feature is the result of a unique depositional environment rather than the evidence left by a discrete cultural activity.

It is hypothesized that the presence of the large sandstone rock has acted to stabilize the underlying soil deposits and provided a protective capping that isolated the bone elements from disturbance by post-deposition agencies (see Figures 12 and 26). In effect then, the deposit of bone is perhaps representative of the kinds of remains that once proliferated the camp and processing site but that ordinarily would have been substantially altered by weathering and trampling prior to burial. This has important implications concerning our model of secondary butchering and processing activities associated with the camp and processing site, for it appears that some cranial and axial portions were being transported to, and processed in, the camp area.

We would assume that the smaller bison may have been transported more or less intact to the processing site, and this could explain the presence of the cranial and axial remains, if they were in fact from

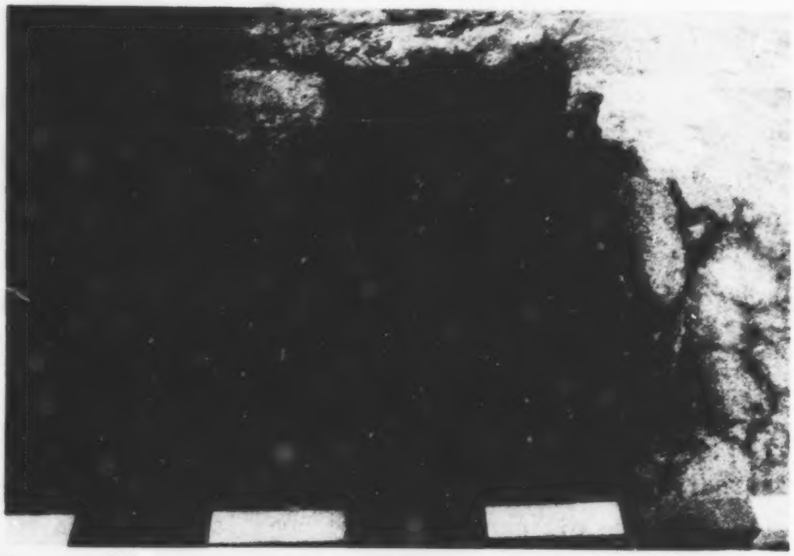

Figure 26. Profile view of feature 25-1.

immature animals. The presence of mature specimens in the processing site indicates that our model of dismemberment and transport from the kill site cannot be viewed as always being the norm.

In summary then, the bone feature under consideration is not seen to be the result of a discrete prehistoric activity; rather, it is the fortuitous result of a unique set of depositional circumstances afforded by the presence of a large tipi ring rock.

Feature 26-1

This concentration of bone elements is representative of a class of features which have been categorized under the title "bone uprights". These kinds of features have been recorded on several archaeological sites in the plains (Gruhn 1969; Kehoe 1967; Keyser 1979; Munson 1984; Neuman 1975; Quigg 1975), the majority of which appear to be associated with Besant occupations (1500-2000 years B.P.). Unfortunately, the sample of bone submitted for C-14 assay proved to contain insufficient collagen for purposes of an accurate radiocarbon estimate (David Arnold pers. comm. 1985). The composition of these features is highly variable, and they have been noted to occur both in kill sites (notably pounds) and associated processing sites. Only one author has attempted to assemble a typology of these features, and three classes of feature have been defined (Munson 1984). These include single bone uprights (the equivalent of a bone peg), multiple bone uprights loosely packed into a pit, and multiple bone uprights tightly packed into a pit (Munson 1984:38-49).

Bone upright 26-1 falls into the category of multiple bone uprights packed loosely into a pit (Figure 27). The composition of the elements used to form this feature is presented in Figure 28, where it is evident that mostly appendicular remains have been employed. The smaller bone elements, such as phalanges, have presumably been employed as packing material between and surrounding the larger upright portions of bone, and a number of small pebbles were also used to stabilize these bone columns. The bone elements placed in the upright position have been modified so that their bases are tapered, thus facilitating insertion into the subsoil. The pit containing the bone is actually a rodent burrow, as revealed by the feature profile in Figure 29. It appears

Figure 27. Plan view of feature 26-1.

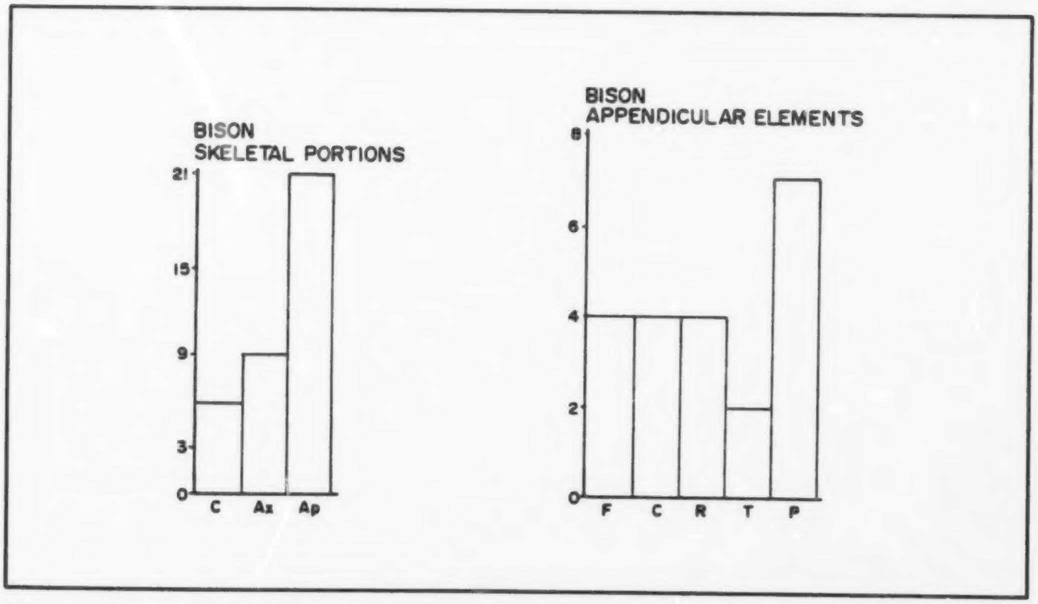

Figure 28. Feature 26-1 content summary.

Figure 29. Profile view of feature 26-1.

likely that the soft fill of the infilled burrow was preferred over the surrounding hard packed substrate for the insertion of the bone elements.

The interpretation of these features has proven to be a problematic issue for plains archaeologists, as a variety of functions have been postulated, none of which is universally satisfactory. Those bone uprights that are loosely packed are assumed to have provided support structures for an inserted wooden stake. These kinds of uprights are usually found in association with pound structures and presumably helped to form the walls of the trap or associated drive lane wings. In the case of the tightly packed bone clusters, it appears that there is no space remaining for the insertion of a stake and their function remains debatable.

Neuman (1975) has suggested that these tightly packed "pillars" of bone may have served as stable anvil platforms that were used in the reduction of lithic materials. In the instance where these features occur in association with kill site deposits, such as is the case at the Muhlbach site, this interpretation seems dubious. It is more likely that they were associated with the pound structure, although their purpose remains open to speculation (Gruhn 1969:139).

Munson (1984) has suggested that the two classes of multiple bone uprights are devices for securing guy lines to support tipi structures. This obviously requires that the bone feature be in close association with the remains of a tent ring, and such is not always the case at the various sites which yield these kinds of remains. At HSI, it is possible that the bone upright was employed in securing the nearby ring structure, as it occurs on the windward side of the ring. The practise of securing the tops of tipis by means of a peg and guy line is documented ethnographically, specifically in the presence of gale force winds (Fidler 1792-1793:24-25). It is unclear what form the pegs took, but it is conceivable that a wooden stake driven into the midst of a loosely packed assemblage of bone uprights would provide the support required. The composition of feature 26-1 accords well with the latter explanation, although some anomalies remain unexplained. For example, why is it necessary to employ in excess of 30 bone elements to secure a single wooden stake when far fewer elements would have sufficed? Also, if the upright is an anchoring point, would it not be more effective located more than a metre's distance from the ring's perimeter? The forces generated by the winds at HSI are legend among those who have worked at the site, and it appears requisite that guy lines be set with as low an angle of incidence as possible to ensure maximum anchoring strength. It is doubtful that the 26-1 upright would be able to withstand a full force wind at HSI given its close proximity to the ring structure. Unfortunately, there is little else we can offer as a functional explanation for this feature and, although in some respects, it may appear ill-suited to the task, we assume this multiple bone upright was used to secure a guy line. The presence of another bone upright feature immediately to the south of 26-1 provides tacit support for the latter interpretation in the sense that more than one anchoring point may have been used and, thereby, helps to explain the anomalous positioning of 26-1.

Feature 26-2

This tightly packed multiple bone upright feature is located 50 cm south of feature 26-1 and is comprised of only three elements (see

Figures 12 and 30). The distal portions of the radius and ulna are articulated, and the broken ends have been forced into the sediment and do not occupy a pit as was the case with 26-1. Wedged tightly beside these latter bones is the distal portion of a metatarsal, and it is also placed with the broken end downward (Figure 31).

This bone upright feature is far less substantive than the previously discussed upright and extends only 8 cm into the substrate. It appears unlikely that this minimal depth would have provided sufficient strength to act as a securing device, and none of the articular ends of the bones reveal evidence of battering as would be the case had the feature been used as an anvil. There is no evidence of a post hole nearby that could have been strengthened by this wedge of bone, and there is insufficient space for the insertion of a wooden stake. We are therefore unsure as to the function of this feature. Only the fact that it occurs in close proximity to the former bone feature and tipi ring structure promotes its interpretation as a subsidiary securing point for a guy line support.

Feature 26-3

This large pit feature is irregular in plan view and shaped somewhat like an elongated oval. The profile of the pit reveals that it is relatively shallow but, moreover, that it appears to be composed of two overlapping depressions, hence the unusual plan shape (Figures 32 and 33). The contents of the feature include a variety of bison elements, many of which were concentrated in the southeast section of the pit. A large assemblage of FBR was also primarily concentrated in this southernmost depression.

The matrix in the northernmost depression was primarily dark organic sediment containing burnt bone and charcoal flecks. The southern depression revealed clear evidence of in situ heating and contained some ash and charcoal deposits. A radiocarbon assay on bone collagen from this feature yielded a determination of 860±380 years:A.D. 1090 (AECV-67c).

The assemblage of bison bone recovered is detailed in Figure 33 where it is noted that appendicular remains predominate. Of these, the

Figure 30. Plan view of feature 26-1 (foreground) and 26-2 (background).

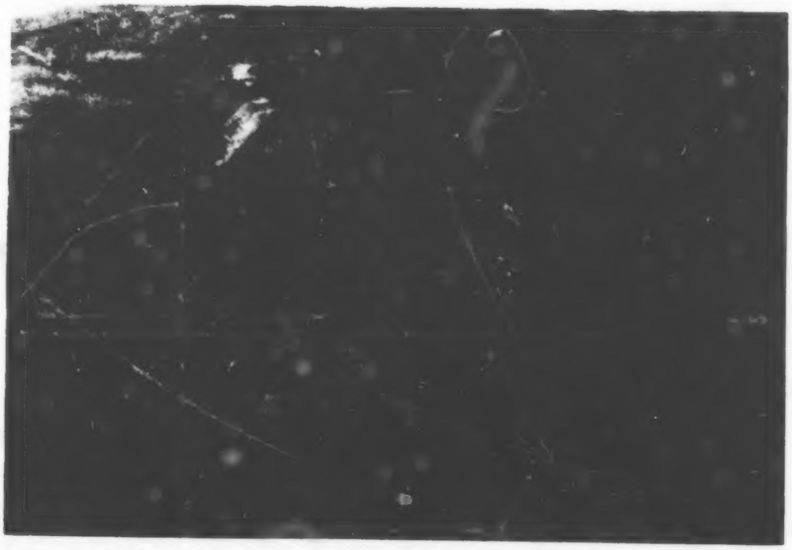

Figure 31. Profile view of feature 26-2.

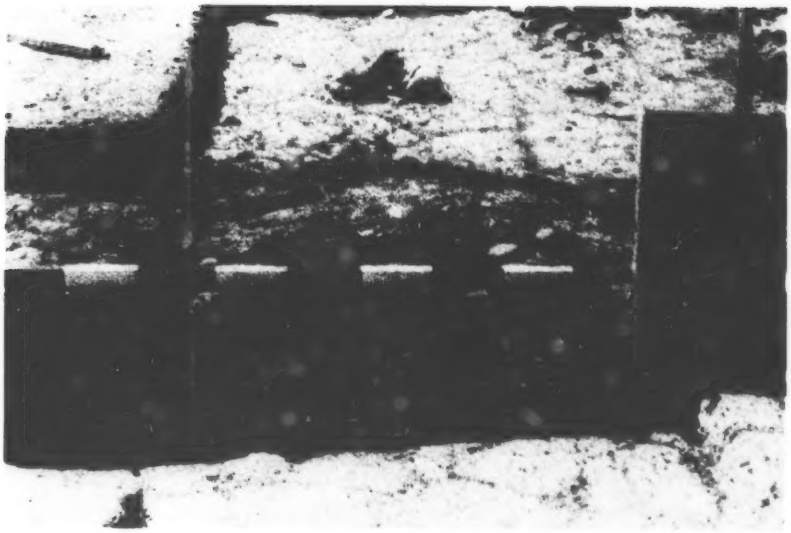

Figure 32. Profile view of feature 26-3.

elements of the fore and rear limb are numerically superior to those of phalanges and sesamoids, a marked departure from previous feature assemblages. The non-identifiable bone assemblage reflects an essentially unimodal distribution that is felt to be characteristic of taphonomically reduced bone fragments.

The FBR assemblage is primarily composed of non-sandstone rocks, and the majority of these fall in the 5 cm size class. As noted earlier, these remains were concentrated in the southern pit depression, and this accords well with the evidence of in situ heating in this area.

This feature is interpreted to be the remains of a circular pit hearth measuring approximately 40 cm in diameter and 10 cm deep that was subsequently superimposed by a less distinct and shallow depression feature measuring approximately 60 cm in diameter and less than 10 cm in depth. Based on the evidence at hand, this latter feature may have been the result of a natural depression being infilled with living surface debris, thereby obscuring the adjacent, but probably unrelated, pit hearth.

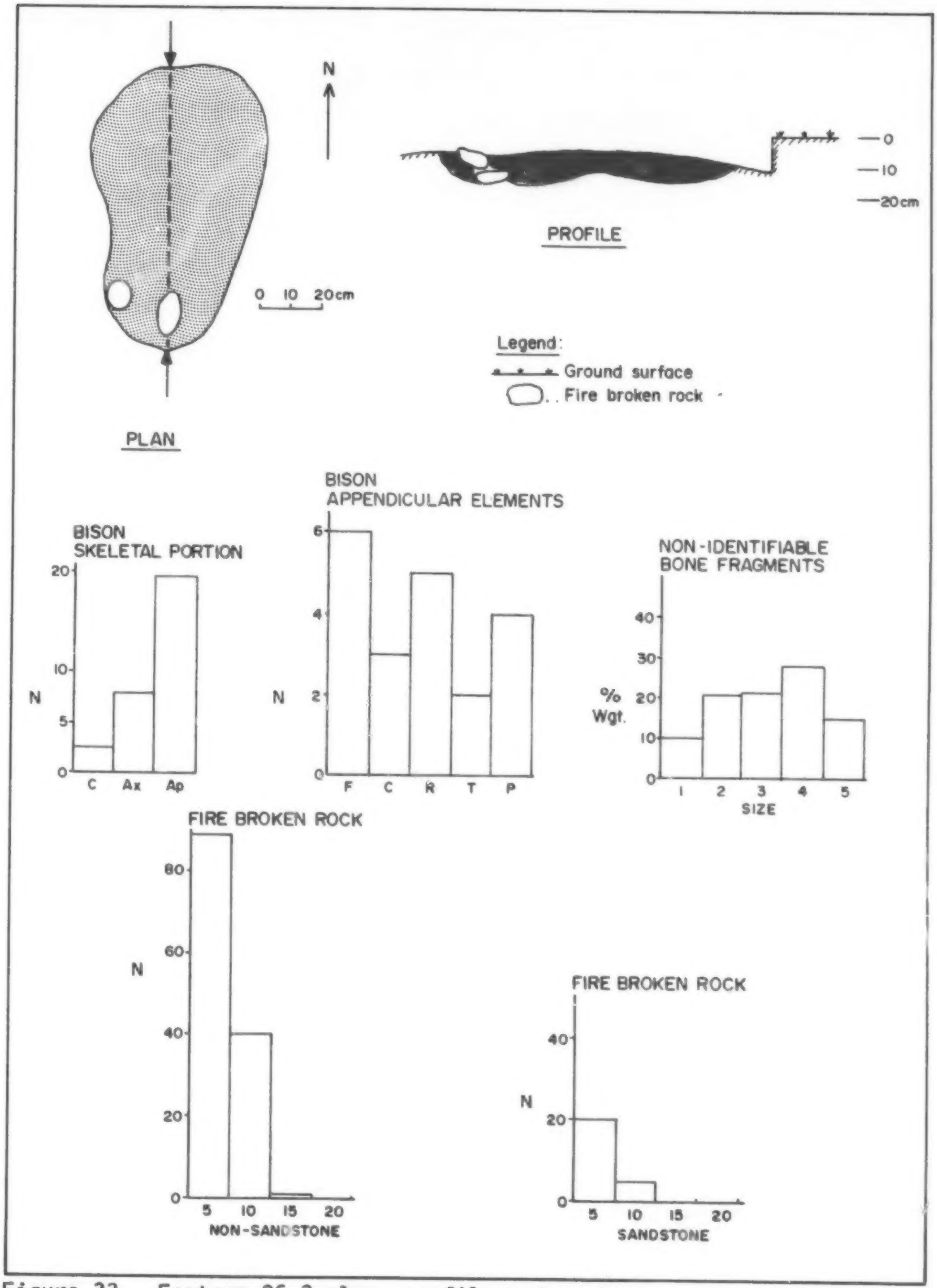

Figure 33. Feature 26-3 plan, profile and content summary.

Feature 27-1

This pit feature is very reminiscent of the former feature in the sense that it appears to be an amalgam of two pit depressions. The plan shape of this pit is ovate with notable constrictions in the eastern portion of the pit at the point where the two depressions interface (Figure 34). This zone of intersection is particularly noticeable in profile and indicates that the westernmost pit is approximately 10 cm deeper than its eastern counterpart. There is no distinct break between matrices of the respective pits, and it is postulated that the depressions are more or less contemporaneous. The remains recovered from this feature certainly appeared to have been uniformly distributed between the two depressions.

A significant number of axial and cranial remains were removed from this feature, including a horn core and mandibular portions (Figure 35). However, the majority of bone elements were from the appendicular skeleton. This is significant, for the detailed breakdown of the appendicular bone reveals a predominance of fore and rear limb elements. This accords well with the findings from nearby bone Feature 22-2, which was postulated to contain circumstantial evidence of bone processing for marrow extraction (see Figure 12). Notably, the majority of the limb bones represented in 22-2 and 27-1 are forelimb bones, thus adding further support for the processing of bison limb bones in this particular area of the block excavation.

The FBR assemblage associated with this feature is not exceptional, being largely composed of 10 cm and greater sized fragments of non-sandstone cobbles. There was, however, a tendency for the stone to be concentrated in the deeper pit depression. These remains were not in any definite cluster, and the admixture of axial and appendicular bone elements gives the impression that these remains are not in primary context and, therefore, represent infiltrated debris. This is not to intimate that the remains are not associated with the use of the pit feature, for it is most certainly the case that they are. It is simply pointed out that the association of the remains recovered in the archaeological context is not necessarily the equivalent of the prehistoric context in which they were originally assembled.

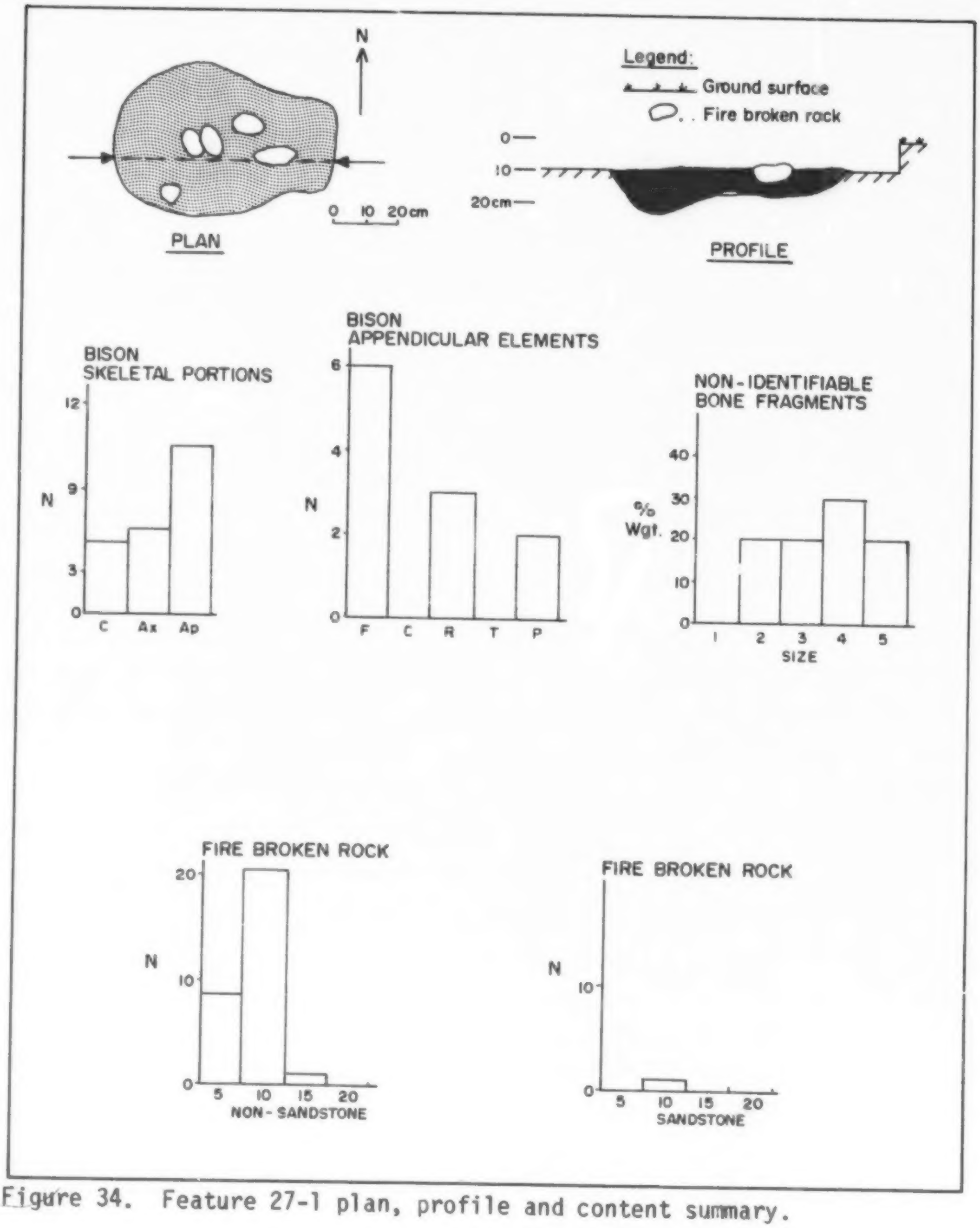

Figure 34. Feature 27-1 plan, profile and content summary.

The plan and profile exposures of the pit clearly illustrate the jumbled nature of the remains and the dichotomous assemblage of bone elements represented (Figures 35 and 36). There is no evidence in the pit matrices of direct heating. Neither is there an abundance of ash or charcoal remains included in the pit fill. We can, therefore, safely exclude a hearth function for this feature. The absence of significant numbers of bone fragments would seem to negate the presence of bone grease processing as would the ample evidence of articular ends of bone that would be consumed by such activities.

It appears most reasonable that the pit may have been used as a cooking facility that was lined with an impermeable membrane, filled with water and heated with boiling stones. This could have facilitated the cooking of marrow plugs extracted by the cracking of many limb bone elements recovered within and in the vicinity of this feature, as well as to obtain the residual marrow that cannot be shaken out of the ends of the marrow chamber, thus making a soup. The nature of the hard compacted sediments at Head-Smashed-In would argue in favour of a shallow excavation, and experimental observations documented elsewhere in this report indicate that shallow draft features possess some functional advantages over deeper pits. A radiocarbon assay on some of the bone from this feature yielded a determination of 470±90 years:A.D. 1480 (AECV 65c) radiocarbon years before present, making it coeval with a nearby hearth, Feature 33-1, discussed below.

Feature 30-1

This pit feature is composed of a compact deposit of large FBR pieces interspersed with a few bone elements. The dimensions of the pit are defined on the basis of the rock concentration; no pit outline could be discerned. The concentration measures 50 cm in diameter and extends to a maximum depth of 28 cm below surface. The plan and profile views of the feature are illustrated in Figures 37 and 38, respectively.

The bone elements recovered from this pit are primarily appendicular remains, the majority of which are phalanges (Figure 39). An axial element from this pit was submitted for C-14 dating, and returned an estimate of 190±80 years:A.D. 1760 (AECV 64c). The elements represented are not diagnostic of any specific processing activity, and the

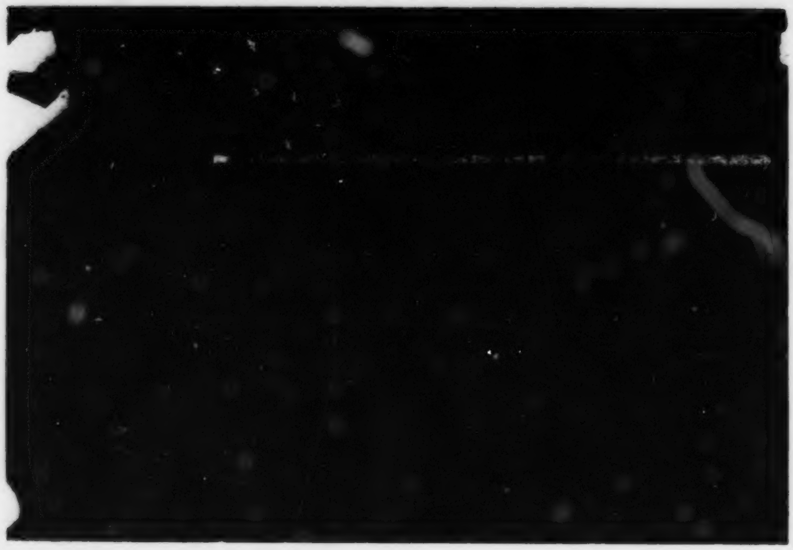

Figure 35. Plan view of feature 27-1.

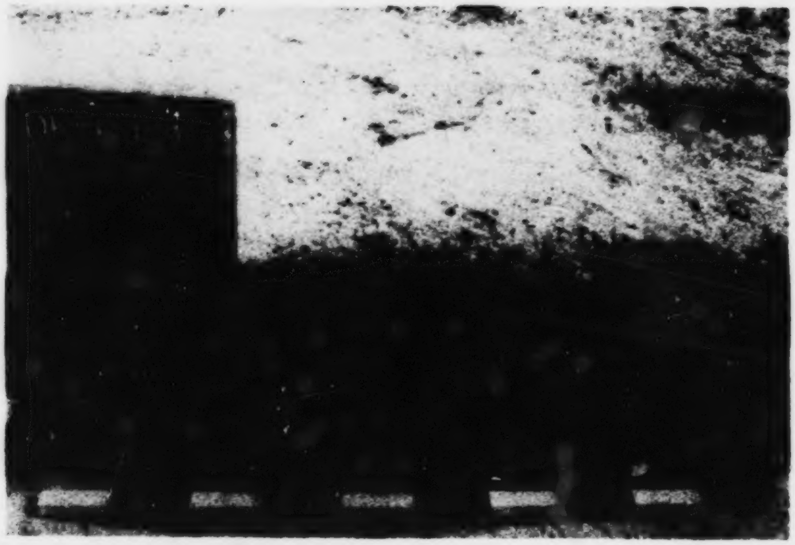

Figure 36. Profile view of feature 27-1.

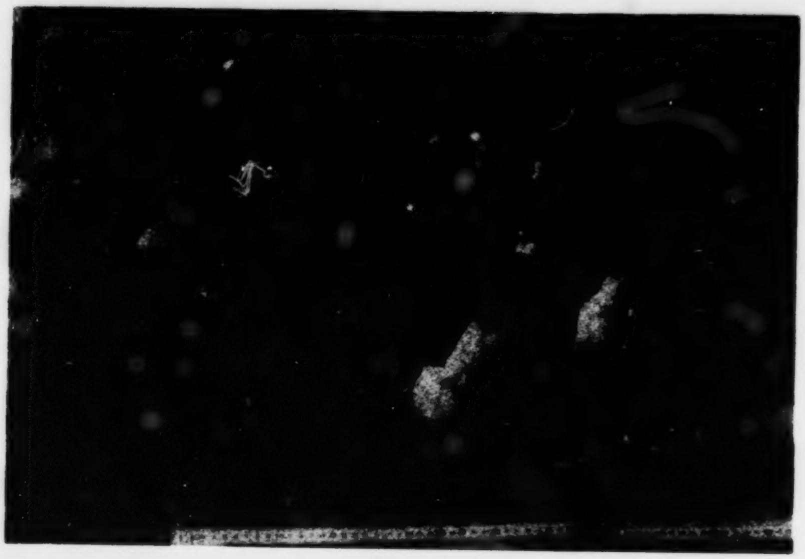

Figure 37. Plan view of feature 30-1.

Figure 38. Profile view of feature 30-1.

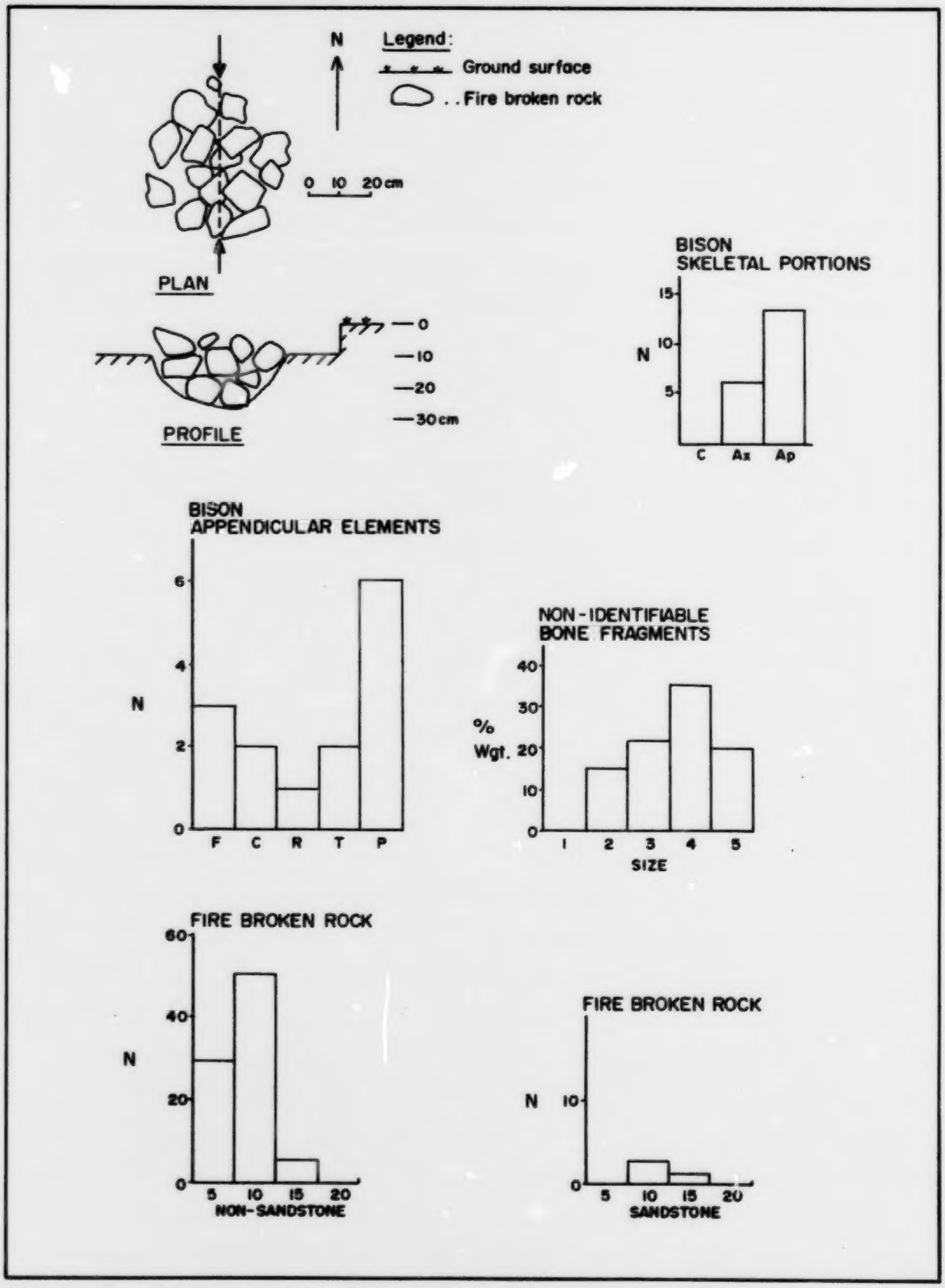

Figure 39. Feature 30-1 plan, profile and content summary.

non-identifiable bone fragments reveal a nearly unimodal distribution of fragment sizes. The FBR assemblage is the most notable aspect of the pit contents owing to the large size of the fragments.

Elsewhere (Frison 1973), pits containing dense concentrations of large sized fragments of FBR have been interpreted as rock heating facilities. There is, however, no evidence of in situ heating of the pit margins, and it is therefore unlikely that a heating facility is represented in the case of Feature 30-1. It seems most probable that the remains contained in this pit represent a cache of large FBR pieces that were placed in a depression for future use but were never exhumed. This is, admittedly, a highly speculative assignment, particularly given the fact that many small pieces of broken rock are also included in the pit fill. However, the obvious preference for non-local rock types for use as boiling stones creates a situation where caching of these rocks for future use could save considerable labour.

Feature 31-1

This pit feature is composed of a compact cluster of FBR fragments with a few bone elements found between the tightly packed rock portions. In both its form and content, this pit is quite reminiscent of the previously described feature, but some notable differences are evident. No pit outline could be discerned and the perimeter of the rock concentration defines an irregular plan shape measuring 55x40 cm (Figure 40). Pit depth is also defined from the maximum extent of the rock, which reaches 20 cm below surface.

Although there was some identifiable bone in the pit fill, it was essentially insignificant (n=5), as was the minute quantity of small, unimodally distributed, non-identifiable bone fragments. Charcoal recovered from the interstices of the rock fill yielded an age estimate of 470±110 years:A.D. 1480 (AECV 59c). It seems obvious that this feature is primarily a rock filled pit and might, therefore, represent yet another cache of FBR. The only problem with this interpretation is the presence of several very large pieces of heat altered sandstone, begging the question as to why sandstone would be cached when it is available locally and in abundance. The large size of the rock included in the pit certainly lends credence to its interpretation as a stock

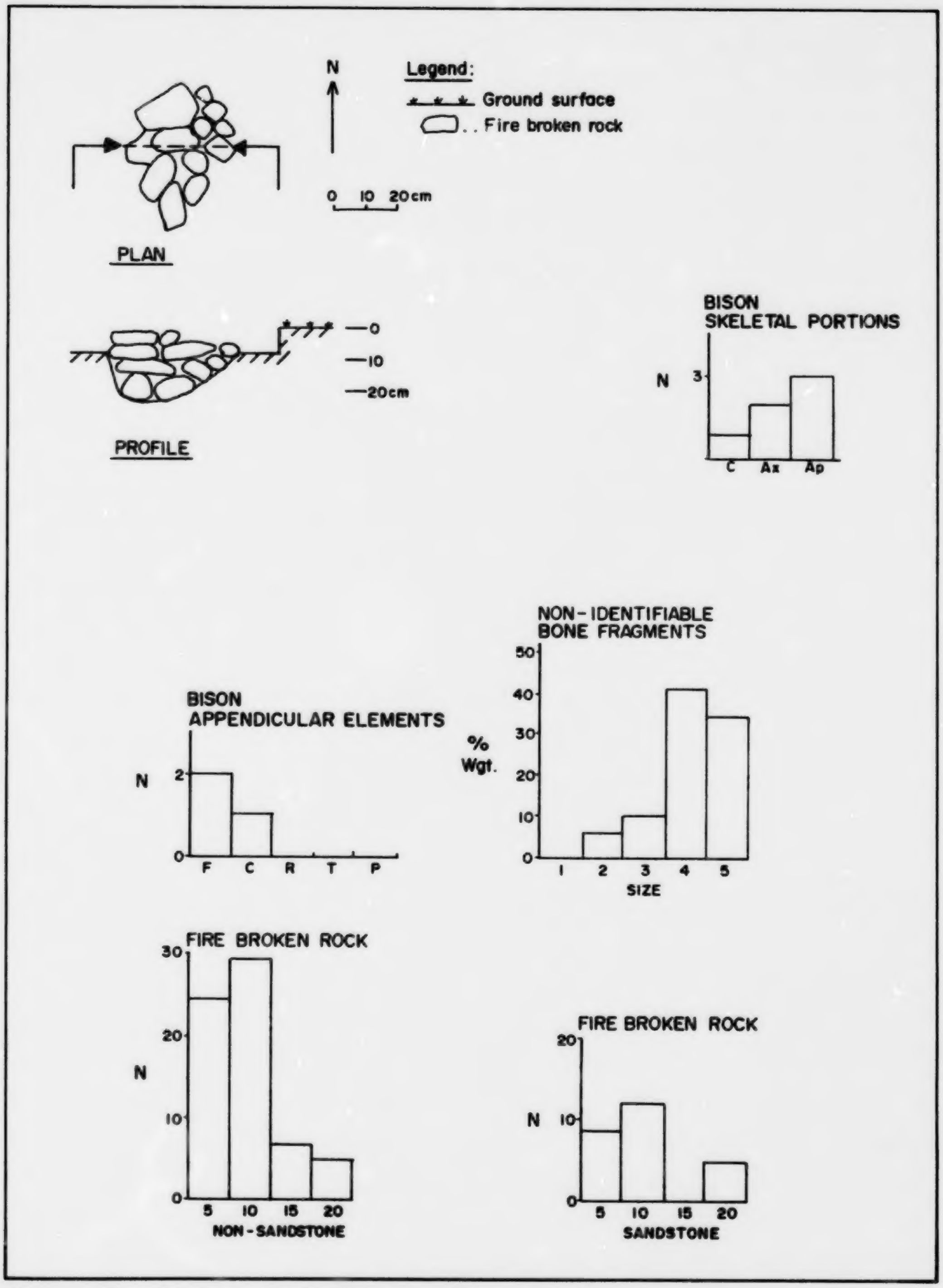

Figure 40. Feature 31-1 plan, profile and content summary.

pile, and the absence of heat altered sediments along the pit wall appears to discount its use as a rock heating pit. There is, however, another interpretation that can be offered, and that is the designation of Feature 31-1 as a sweat bath pit.

Several ethnographers mention the use of sweat baths by plains Indians, but only one provides information regarding the pit which was used to contain the heated rock. Turney-High (1941:64) records the dimensions of a sweat lodge pit as being two feet in diameter and one to two feet in depth. This is somewhat larger than the feature under discussion, but given the vagaries of ethnographic measurements, the account conforms quite closely with the structure of feature 31-1. The confirmatory evidence which is missing is evidence for the sweat bath cover, but this may have been represented by shallow post holes which could have easily been missed during excavation. The ephemeral nature of these posts and the basic configuration of the pit which contains the heated stone is plainly evident in the construction details of a modern sweat bath. The structure in Figures 41 and 42 was recorded on the site of a Sun Dance ceremony which was recently held on the Peigan Reserve just south of the Head-Smashed-In site.

To conclude, it is far from certain that this pit represents the remains of a sweat bath rock pit, for it is possible to equate these remains with other kinds of activities. This functional interpretation is only offered as one of several possibilities, although the nature of the remains suggests it is probably one of the more likely possibilities.

Feature 31-2

This concentration of bone elements was not recognized as such until the field plots of the bone distribution were reviewed. The remains appear to have been distributed in a roughly circular concentration measuring 65 cm in diameter. The bone extended from the base of level one to the top of level two, yielding an approximate total depth of 8 cm. The composition of the remains is illustrated in Figure 43, where it is evident that appendicular remains predominate. While the majority of the appendicular elements are phalanges, there is a significant representation of both the fore and rear limb long bones. These remains

Figure 41. Sweat lodge structure near Brocket.

Figure 42. Sweat lodge stone pit (note forked lifting poles).

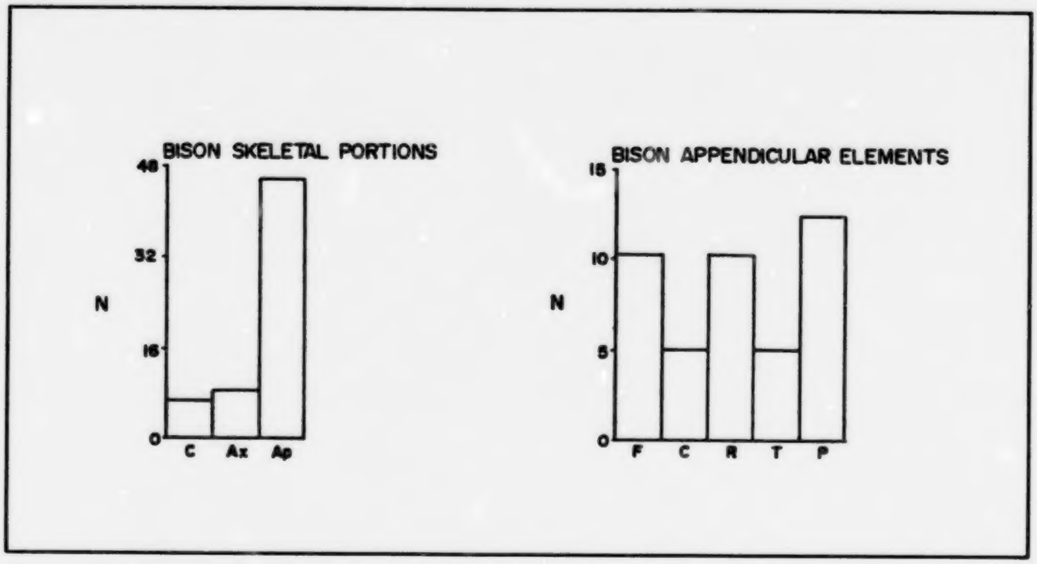

Figure 43. Feature 31-2 content summary.

are largely represented by the articular portions of the bone, suggesting that the mid-shaft section may have been destroyed in the process of extracting marrow. It is interesting that this concentration of elements occurs in the immediate proximity of the former feature. The implications of this apparent association will be discussed further in the consideration of the spatial distribution of bone processing activities within the block excavation.

Feature 33-1

This and several of the feature descriptions which follow represent the only hearths recorded within the block excavation. It is perhaps significant that these hearth areas cluster within the confines of the tipi ring structure, albeit not in the central portion of the ring.

Hearth Feature 33-1 is a well-defined circular pit hearth measuring 46 cm in diameter, with a maximum depth of approximately 8 cm. Owing to extremely dry conditions at the time of its exposure, this feature had to be water sprayed and repeatedly troweled before an accurate determination of its plan shape and dimensions could be ascertained. As a result, the profile depicted in Figure 44 provides an inexact depiction of the actual feature depth.

In plan view, this hearth reveals a well-defined rim of oxidized sediments along the west and south margins of the pit, while the central portion is composed of dark sediments with inclusions of ash, charcoal and burnt bone (Figure 45). Only three small fragments of FBR were recovered from this feature, and none were observed when troweling down the upper layers of the hearth fill. A radiometric assay on charcoal from this feature yielded an estimate of 530±140 years:A.D. 1420 (AECV-61c).

Feature 33-1

This hearth feature is located immediately to the north of the former pit hearth and is less well defined. The plan view is defined on the

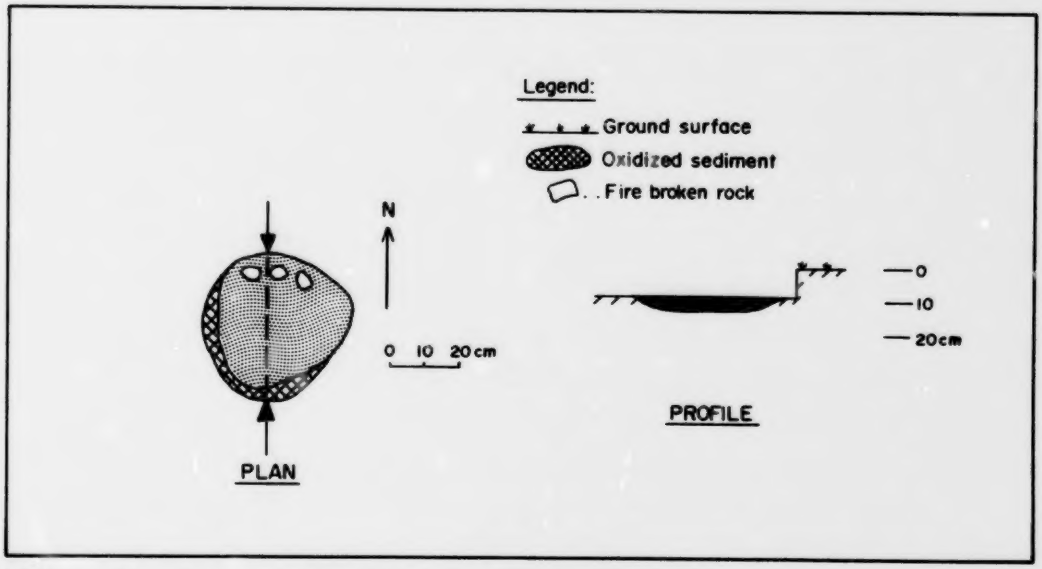

Figure 44. Feature 33-1 plan and profile.

Figure 45. Plan view of feature 33.1.

basis of a roughly ovate oxidization stain measuring approximately 65 by 45 cm (see Figure 12). This is a most unremarkable feature in that there was no depth to the oxidization layer and, while the profile did extend 3 cm into the subsoil in places, overall it was highly irregular. The eastern portion of the hearth revealed an additional feature in the form of a small circular stain of dark sediment measuring 20 cm in diameter and 4 cm in depth; its significance remains undetermined.

This hearth feature is, in many respects, reminiscent of some of the hearth stains that were created in the course of experimental replications of prehistoric hearths discussed elsewhere in this report (see Chapter 5). These fires were generated using bison chip fuel within pit depression and surface type hearths. The surface hearths were fired several times, yielding an oxidization stain that was roughly circular in plan view but extremely irregular in profile. As the major source of fuel at Head-Smashed-In would have undoubtedly been bison chips, it is perhaps predictable that stains such as 33-2 should be encountered in the camp and processing site deposits.

Feature 33-3

This small bone concentration was encountered on the northern perimeter of the block excavation and, while additional remains may reside outside the excavation unit, there was no obvious indication of this in the wall profile. The bone elements are not confined within a pit or a rodent disturbance, and it is difficult to determine what agency deposited these remains. The bone forms a relatively compact bundle measuring 30 cm in diameter and occurring between 10 and 30 cm below surface. A variety of bone elements are represented, including a complete mandible, some vertebral portions and several appendicular elements (Figure 46), none of which reveal any obvious hallmarks of secondary processing.

There is no FBR or organic sediment associated with these remains and, although the best explanation of such a deposit would appear to be

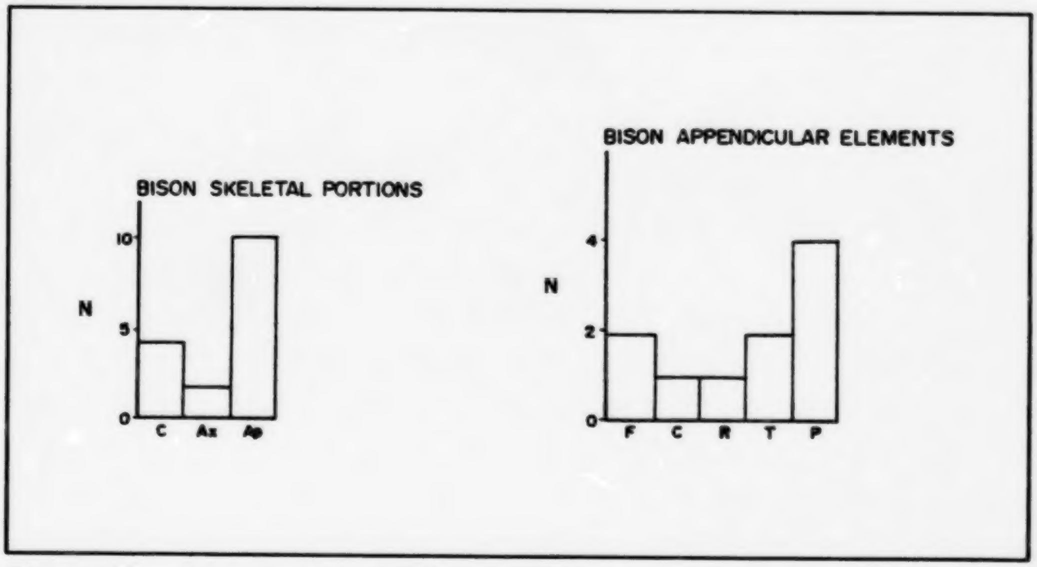

Figure 46. Feature 33-3 content summary.

an infilled rodent burrow, the surrounding matrix is uncharacteristic of such a deposit. Although dessication features are replete throughout the HSI substrates, they are usually narrow and filled with dark organic sediment and provide no ready explanation for this bone feature. Though the ultimate cause of this bone concentration remains undetermined, it appears fairly certain that cultural agencies can be safely discounted.

Feature 33-4

This is the final hearth feature recovered from this unit and, like the former example, it is composed of a shallow oxidization stain and reveals an amorphous plan shape. The plan configuration of the hearth appears as two overlapping ovate stains, but the profile reveals no evidence of such a structure. It is presumed that this hearth was the result of several individual firing episodes which tended to shift locations on each occasion. This would be especially likely to occur in a non-bounded surface hearth, for there are no controls on the perimeter of the fire. In addition, it is evident that a bison chip fire often results in a more irregularly shaped hearth stain than that which is formed by a wood fueled fire. Presumably, this is related to the manner in which the fuel is stacked and the radiant heat properties peculiar to each fuel type. A more detailed discussion of these points is included in Chapter 5 of this report, which presents the results of an experimental project.

Feature 37-1

Although this large feature is designated a bone concentration, it contained a substantial assemblage of fire broken rock. In fact, the FBR distribution is employed to define the feature perimeter (Figure 47). Unfortunately, this feature was not recognized until after the western half of the stone and bone concentration had been removed, but the basic morphological attributes of this stone and bone concentration were successfully reconstructed from the distribution maps and photos. Part of the difficulty in recognizing this feature arose as a result of there being no pit depression or sediment staining which would have assisted in the recognition of the feature perimeter. The eastern portion of this

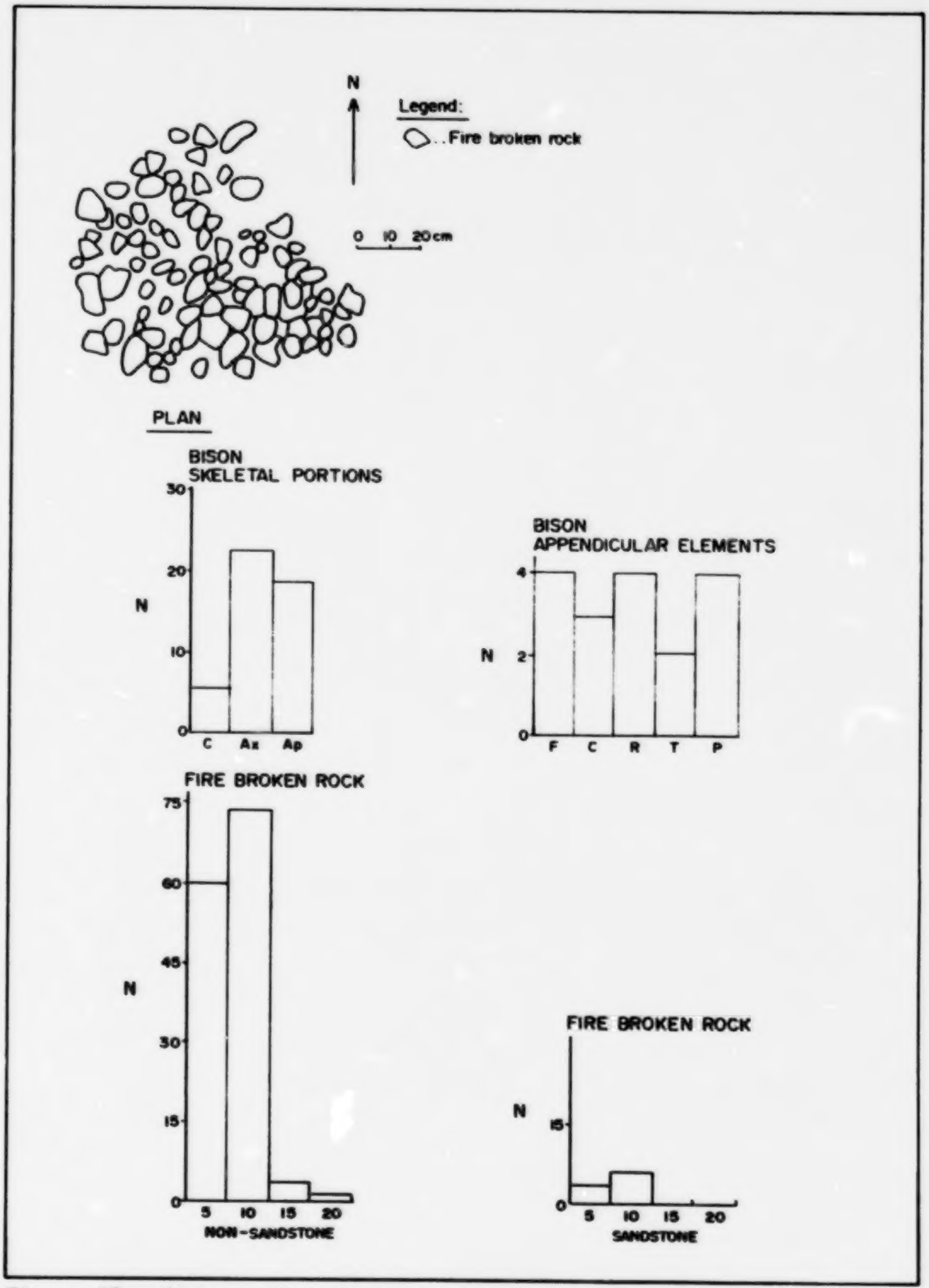

Figure 47. Feature 37-1 plan and content summary.

concentration is illustrated in Figure 48, where it is evident that no obvious staining was present in either the plan or profile perspectives.

The assemblage of bison elements recovered from this feature reveals an uncharacteristic predominance of axial remains, the majority of which are rib portions and fragments of thoracic and cervical vertebrae. The appendicular bone assemblage is represented by remarkably few phalanges, with forelimb and rear limb elements being numerically superior. No discussion is possible regarding the non-identifiable bone assemblage, as no bulk samples were obtained from this feature.

Fire broken rock fragments proliferated throughout the deposit, and the majority of these were non-sandstone materials in the 10 cm size class (Figure 47). There was no indication of direct heating of the sediments in and around the FBR, and it is therefore inferred that these materials were stockpiled and were not used in situ as a heating facility. If this interpretation is correct, it is reasonable to predict that a heating or cooking pit facility should be located nearby to account for this refuse deposit. This, in fact, is the case, as a large pit feature was present less than 50 cm to the east of this concentration. The details of this pit facility are discussed below.

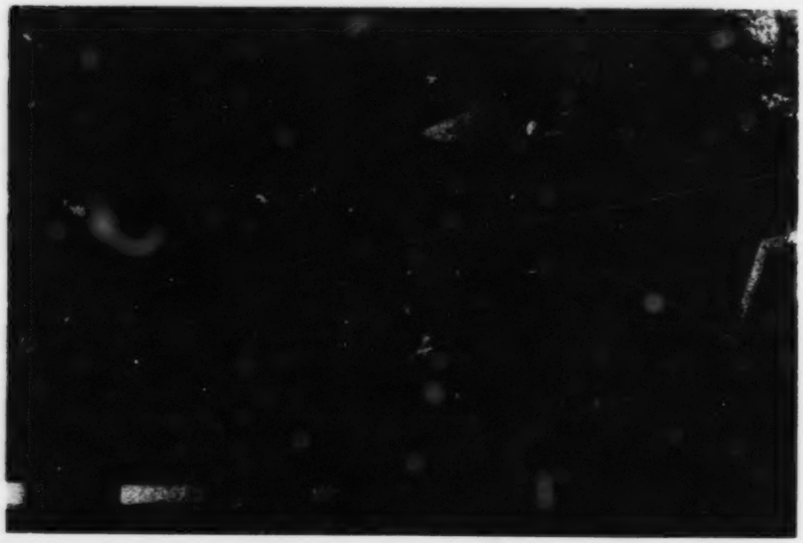

Figure 48. Plan view of feature 37-1.

Feature 37-2

Despite the fact that this pit was only partially exposed, it was the largest facility recorded in the block excavation. The eastern portion of the pit extended outside the excavation but, based on the exposed portion, it is estimated that this circular pit possesses a diameter of 100 cm. The profile reveals a maximum depth of 25 cm below surface (Figures 49 and 50).

Both the plan and profile views appear to indicate that this pit is actually composed of two overlapping depressions (cf. feature 27-1), and that the northernmost depression contains the bulk of the bone and fire broken rock. The southern depression not only contains less bone and stone, but the pit matrix appears to be somewhat lighter in colour, thus begging the question of whether two overlapping pits, or two discrete episodes of pit usage are represented. It is likely that the dark stained sediments in the northern portion of the pit result from the mass of bone and stone deposited in this area, while the southern portion of the feature is primarily composed of loess, which may have infiltrated the pit following its abandonment. The composition of these pit matrices indicates that two very different deposition events are represented, but this does not necessarily imply that they were not contemporaneous.

If this pit feature was lined with an impermeable membrane, a practise which was observed to be the case by several plains ethnographers (Grinnell 1923; Kroeber 1902; Lowie 1909; Skinner 1914), the removal of the hide liner could have resulted in the structure of the deposits observed in the profile. This follows from the lifting of the hide from one side and spilling the pit contents into the opposite side of the pit as the hide was pulled free (cf. Losey 1972). At this point, the pit may have been abandoned and the largely empty southern portion of the pit infilled with surface debris and loess. This sequence of events would satisfactorily explain the dark sedimentary matrix of the northern pit portion given the influx of residual meat, grease, ash and bone residues that would have been present in the pit. The nature of the cooking activities that may have been associated with this pit can be inferentially determined on the basis of the bone residues contained in the feature matrix.

Figure 49. Plan view of feature 37-2.

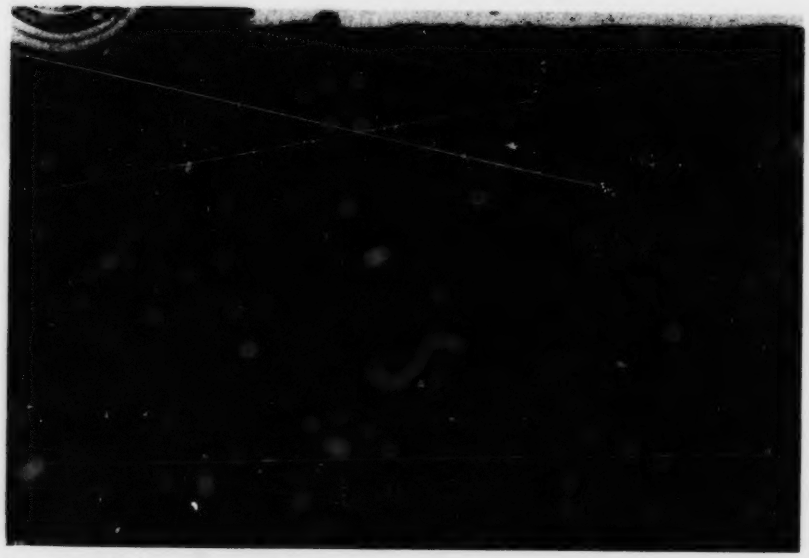

Figure 50. Profile view of feature 37-2.

The assemblage of bone elements recovered from this pit is truly impressive (Figure 51). These remains are primarily composed of appendicular elements, but there is a significant representation of axial elements, notably rib portions, cervical vertebrae and thoracic vertebrae. The appendicular bone assemblage is dominated by the elements of the forelimb and the ubiquitous phalanges and sesamoids.

It is interesting to note that the majority of the humerii, tibiae and radii elements are represented by only distal and mid-shaft portions. Moreover, on the basis of relative size and the identification of sides, it appears that several of the humerii are in fact paired and represent the in situ processing of individual bison. The evidence for bone processing activities seems fairly obvious in this case, for the marrow cavities have been broken open, and none of the proximal articular ends of the long bones were recovered. These proximal element portions are the very ones we would expect to be selected for purposes of rendering of bone grease, given their large size and grease content (Binford 1978; Binford and Bertram 1977). Thus, we envision a specific set of activities to be manifest in the remains recovered from this pit, involving butchering the limb elements and portions of the axial skeleton, notably the hump meat. This would then be followed by breaking of long bone elements, extraction of marrow and, finally, breaking the large articular ends into smaller pieces and rendering same in the boiling pit until the grease could be skimmed off and stored.

In the course of this activity, hot rocks would need to be added to the mix periodically, and the cooled rock and degreased bone portions removed. We suspect that the nearby residues recovered from Feature 37-1 are the result of such activities. The analysis of the non-identifiable bone fragments reveals a predominance of the larger sized fragments and relatively few of the smallest size class. These bone fragments are quantitatively and qualitatively consistent with the residues we could expect from bone grease processing with some admixture of mid-shaft fragments resultant from marrow extraction. We suspect that the pit was probably used for a variety of purposes, including boiling meat sections, cooking marrow and rendering bone fragments for their grease.
Inevitably, these composite activities will result in composite feature

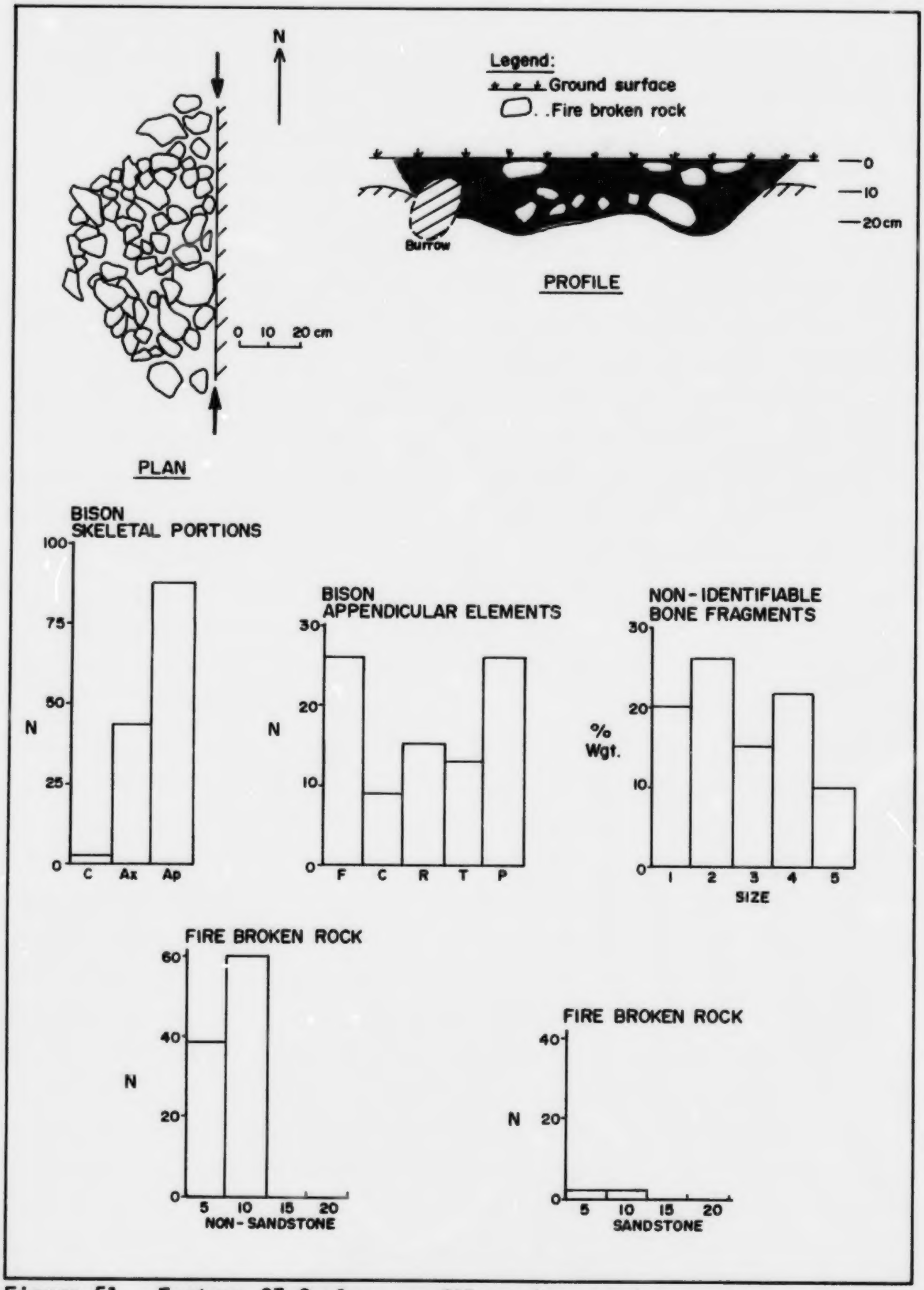

Figure 51. Feature 37-2 plan, profile and content summary.

fills and the admixture of surface debris following the abandonment of the pit further obscures the context of these remains.

The FBR assemblage is almost entirely composed of non-sandstone cobbles, and most of these fall within the 10 cm or greater size classification. These remains accord well with those found in the adjacent Feature 37-1, for the FBR occurs in roughly the same proportion, based on size and material type.

A sample of charcoal was obtained from the flotation of the feature matrix, and this was submitted for C-14 dating. The sample yielded an estimate of 680±110 years:A.D. 1270 (AECV 119c), which falls well within the range of the majority of the other features from the block excavation.

Summary

The previous discussion presented a detailed description of the various kinds of features recorded in the block excavation area. This section summarizes these data, encapsulating the chronological and functional aspects of the assemblage and the implications regarding activities conducted in the processing area of Head-Smashed-In.

Although hearths are generally prolific on plains sites (Congram 1978; Fredlund et al. 1985; Quigg 1975), only four were recorded at Head-Smashed-In. Significantly, only two of these hearths appear to have been placed in a pit depression, and neither of the depressions is very deep. These data suggest that hearth preparation was minimal at Head-Smashed-In, and that the majority of hearths were simply built on the ground surface, perhaps surrounded by a rock ring. Rock ringed hearths are recorded elsewhere (Frison 1967; Quigg 1975), and these have been specifically associated with the use of bison chip fuel (Wilson 1924:268). In the latter case, the rock ring is thought to have served as a heat sink as well as a device for containing the fire. A modern hearth associated with the recently abandoned site of a Sun Dance Ceremony is illustrated in Figure 52; although a rock ring was employed, it is evident that the fire was wood fueled.

The amorphous structure of the hearth facilities at Head-Smashed-In suggests that they were used for only brief periods of time and that they were constructed as needed in locations convenient to processing pits and shelters. The majority of these hearths were found within the tipi ring

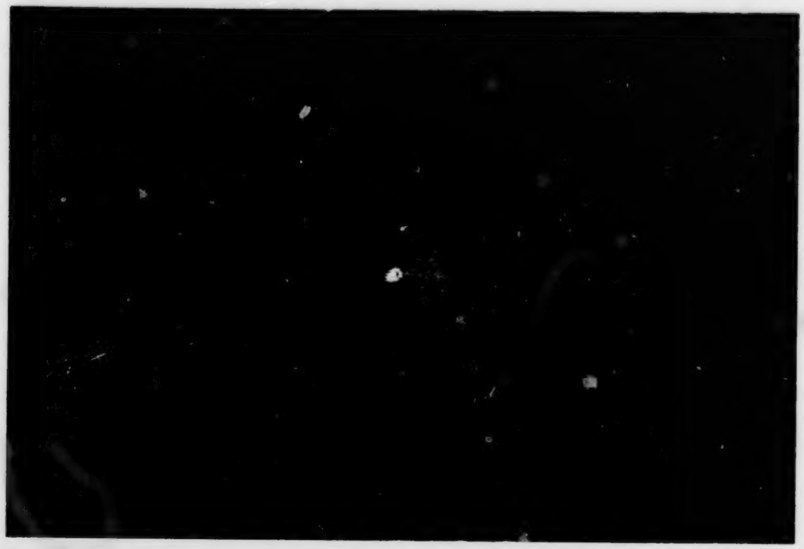

Figure 52. Rock ringed surface hearth near Brocket.

rocks, but this association may be fortuitous. Based upon the results of our experimental bison chip fires, and on the basis of ethnographic accounts, it appears unlikely that this fuel would have been extensively employed within a shelter. It appears essential that a steady breeze be present in order to produce a significant amount of heat, and this requirement would not be met in an enclosed space. It is possible, however, that the practice of raising the perimeter of the tipi cover flaps in the warm season would allow sufficient breeze to render a chip fire practicable within a shelter. These hearths were probably used for purposes of heating boiling stones, heating rock concentrations that were employed as roasting platforms (Wilson 1924:268), and as a source of heat and light.

The three bone upright features recorded from the block excavation exhibit a range of forms and, although their function is not clearly understood at this time, they are tentatively identified as anchoring supports for shelters. Whether these features are associated with a Besant phase occupation of HSI, as would appear to be the case at other sites producing these kinds of remains, is not determinable at this time.

A total of eight pit features were recorded in the camp and processing site during the 1984 field season, and these are thought to have served a variety of functions. Several of the pits revealed a large diameter to depth ratio, and these are hypothesized to represent the remains of boiling pits. Other pits yield a much smaller diameter to depth ratio, and these are presumed to represent quite distinctly different activities. In the instances where these smaller pits are filled with FBR, it is likely that they represent in situ roasting pits or, in the absence of heat altered sediments, a cache of fire broken rock. The possibility was also advanced that one of these rock filled pits may represent the remains of a sweat bath heating pit.

Those pits revealing heat altered sediments and assemblages of bone and FBR are felt to represent the remains of roasting pits which, having been emptied of their contents, were subsequently infilled with surficial camp debris. In some cases, the structure of the feature fill from these pits suggests that several functions may have been served by a single facility. For example, a boiling pit can also be used as a roasting pit with relatively minor modification and certainly with less effort than it takes to construct a new pit depression. In the same vein, it is equally likely that some of the pits recorded at HSI are actually occupying collapsed rodent burrows which could be readily modified to serve as pit facilities (see Figure 53).

A total of five features were recorded under the categorization of bone concentration. These are thought to be the residues of specific processing activities, and it is often the case that the concentration of bone and FBR fragments occurs in close association with one or more of the aforementioned pit features. It is assumed that these residues are the result of the periodic emptying of the boiling or roasting pit, as well as the debris remaining from the processing of bone prior to its placement within the pit. These concentrations of surficially deposited remains and nearby pit features represent potentially discrete episodes of processing activity, and are of particular importance in the determination of the kinds of tasks that were undertaken in the camp and processing site. A discussion of the spatial patterning of these bone residues and pit features is presented in the final section of this chapter.

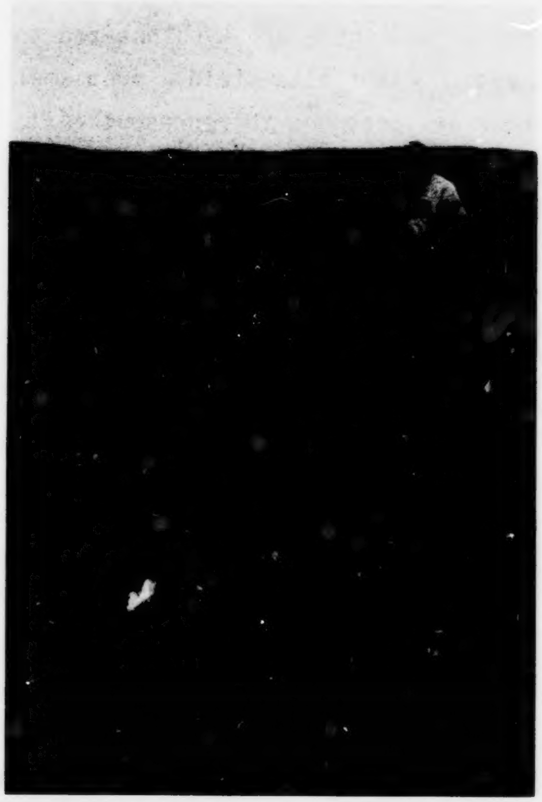

Figure 53. Collapsed rodent burrows near Brocket.

Worked Bone, Antler and Shell

A total of 26 items of bone, antler and shell revealed one or more cut, ground and polished surfaces indicative of either specific usage such as bone bead manufacture or non-diagnostic use-wear from expedient applications. Given the abundance of bone at HSI, it should not be surprising that it was used for tool manufacture. In fact, it is surprising that more evidence of its use is not recovered. It may be the case that many expedient bone butchering tools were used, but that these are deposited in the kill site and different tools used in the camp/processing site. Alternatively, it is possible that bone tools were used extensively in the camp/processing site, but that post-depositional agencies of weathering and trampling have made the identification of such tools very difficult. For example, the faunal analysis recorded few clear examples of butchering marks on the HSI bone, with the exception of those bones recovered from pit features. These bones reveal well preserved cut marks, presumably the result of their rapid burial and the protection afforded by the pit matrix. The fact that over 60% of the tool inventory was derived from pit matrices adds support to the latter argument and suggests that the inventory of tools may not necessarily be representative of the variety of bone tools originally deposited at the site (Table 3).

Worked Bone

The 20 items of worked bone can be conveniently divided into categories of utilitarian and decorative objects. Bone beads and waste products from bead manufacture were recovered from both pit and non-pit contexts. One pit (feature 37-2) yielded 75% of the worked bone assemblage (See Figure 51). The items recovered from the pit include three finished beads and three portions of bone that represent the waste products of bead manufacture. It is evident from the morphology of the beads and bead waste that they were not manufactured from the same bone elements, although they do appear to have been manufactured from the bone of a single animal. The bone bead waste consists of three proximal portions of metatarsals, probably from a wolf (Canis lupus), including elements from both the right and left sides (Figure 54f-h). Both the bead waste and three bone beads were manufactured using the groove and snap technique (Semenov 1976:152-153).

Only two of the beads are complete, and they measure just over 10 mm in length, 6 mm in width and 4 mm in thickness (Figure 54b, c). Both are

Table 3. Worked bone, antler and shell.

Description	n	%
Bone beads and waste products	8	30.8
Bowl awls	6	23.1
Antler	1	3.8
Shell	6	23.1
Miscellaneous worked bone	5	19.2
TOTAL	26	100.0

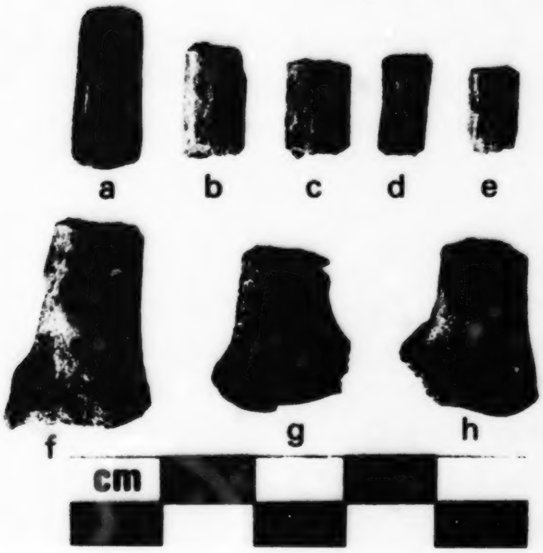
a
b
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Figure 54. Bone beads.

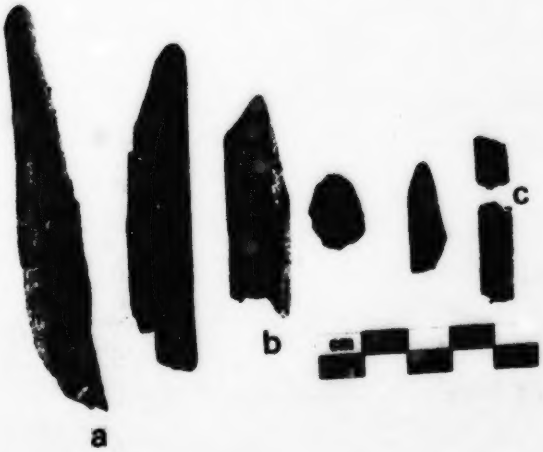


Figure 55. Bone awls.

manufactured from rib bone, probably derived from the wolf mentioned above, and have been drilled from either end to facilitate suspension. The incomplete bead (Figure 54e) is also manufactured from rib bone but the absence of drill marks suggests that it may have broken during the process of grooving and snapping the bone.

The remaining inventory of beads includes one complete specimen exhibiting extensive smoothing and grinding of the bone surface. It measures 17 mm in length, 7 mm in width and 7 mm in thickness (Figure 54a). The final specimen is a bead fragment measuring 11 mm in length that appears to have been manufactured from rib bone (Figure 54d). Although it was not recovered in the vicinity of the large pit feature which yielded most of the beads, the general resemblance in size and morphology is striking and suggests that they all may have originated from the same episode of bead manufacture. Presumably, these objects were used for personal adornment such as necklaces (Grinnell 1893:197) or as components of other personal paraphenalia.

Only one of the six bone awls recognized in the worked bone assemblage is complete. None were recovered from within pit features. The complete specimen measures 91 mm in length and possesses a blunt tip revealing longitudinal striations (Figure 55a). With the exception of two specimens, all of the remaining tools possess blunt working tips. The exceptions are a mid-section of a probable awl (Figure 55c) and a sharply pointed awl manufactured from mammal rib bone (Figure 55b). Given the fragile nature of the working ends of these tools, it is unlikely that they were used during the preparation and manufacture of clothing and shelter covers made from bison hide.

Some of the specimens reveal both transverse and longitudinal striations which are thought to be indicative of the twisting and pushing action associated with the use of bone awls. It appears likely that the blunted nature of these tools is indicative of their exhausted state. The abundance of bone at the site and the lack of evidence for well-formed awls suggests that they may have been employed for only a short time and then discarded in favour of freshly fractured bone surfaces that provided ready made awl tips (Frison 1973:34). Alternatively, some of these blunted awls may have been used as knapping tools, used primarily in pressure retouching lithic tools that became dull during the butchering of the bison and processing of bison by-products.

The remaining bone tools consist of a proximal section of bison rib with a blunted and polished end (Figure 56b), a long bone diaphysis fragment with polished projections (Figure 56e), a cut rib that may have been used as a haft (Figures 56 and 57), a metapodial with deep transverse incising (Figures 56d and 58), and a fragment of long bone diaphysis that has been cut and chipped (Figure 56f). None of the specimens are particularly diagnostic with the exception of the rib haft, which may have been used in association with a scraper or a projectile point as posited by Frison (Frison et al. 1978:17).

Antler

A large section of mule deer antler (Odocoileus hemionus) was recovered from a natural depression feature within the block excavation (Figures 56a and 59). This represents the only antler recovered from the site so far, and it is worked. One of the tines has been whittled off and may represent the waste product from the manufacture of an antler projectile point. No antler points have been recovered from HSI, but they are recorded in the ethnographies (Wissler 1910:158; Morice 1895:56-57). A variety of worked antler portions have been found at several other kill sites (Frison and Walker 1984:40; Kehoe 1967:63).

Shell

The portions of shell recovered from the block excavation were all fragmentary and in a poor state of preservation. None of the pieces were sufficiently complete to speculate on whether the shell items were ornamental or utilitarian. All the shell fragments appear to be derived from local species, which contrasts with the imported shell species recovered during the previous field season (Brink et al. 1985:210). Presumably, the shell was collected from the Oldman River. The continued presence of non-identifiable fish bone in the pit features of the camp and processing site attests to the periodic exploitation of riverine resources. It is likely that such resources were gathered using stone weirs in the Oldman River, as was practised in the early part of this century (Edward Yellowhorn, pers. comm. 1984).

Figure 56. Worked bone and antler tools.

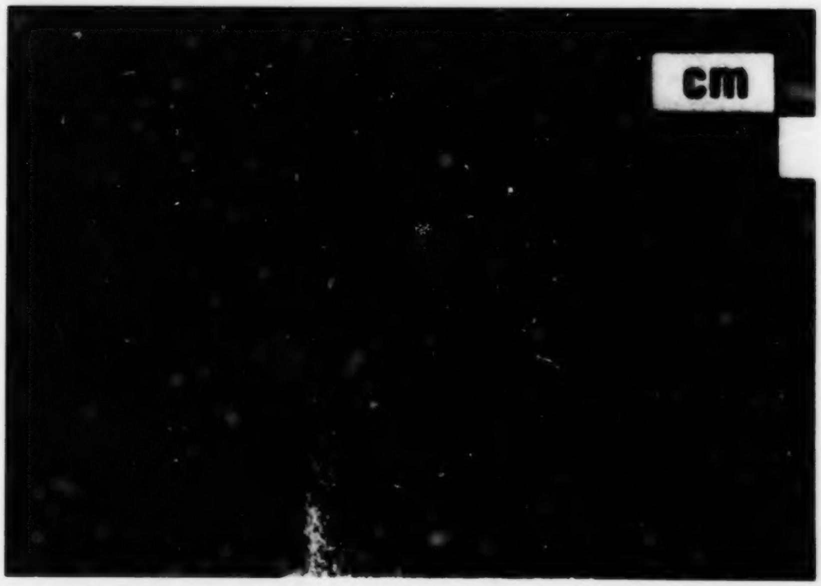


Figure 57. Closeup of worked rib bone.

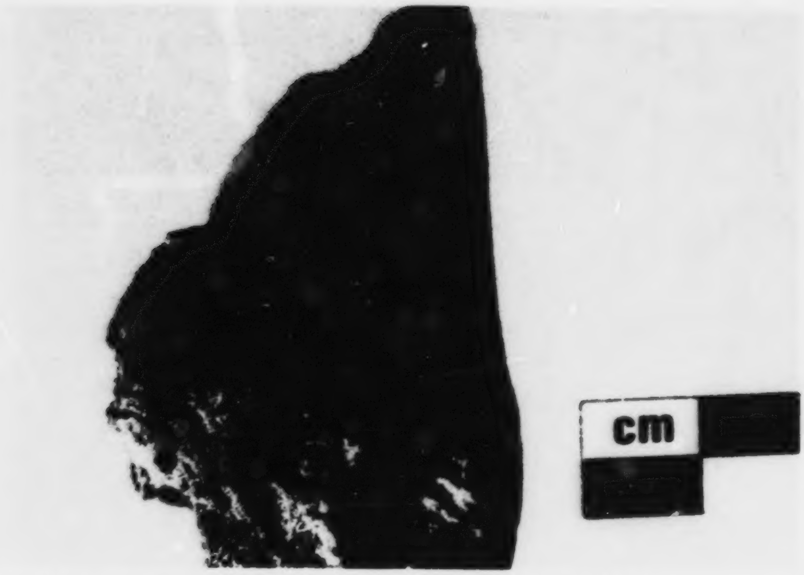


Figure 58. Cut mark on distal end of bison metapodial.

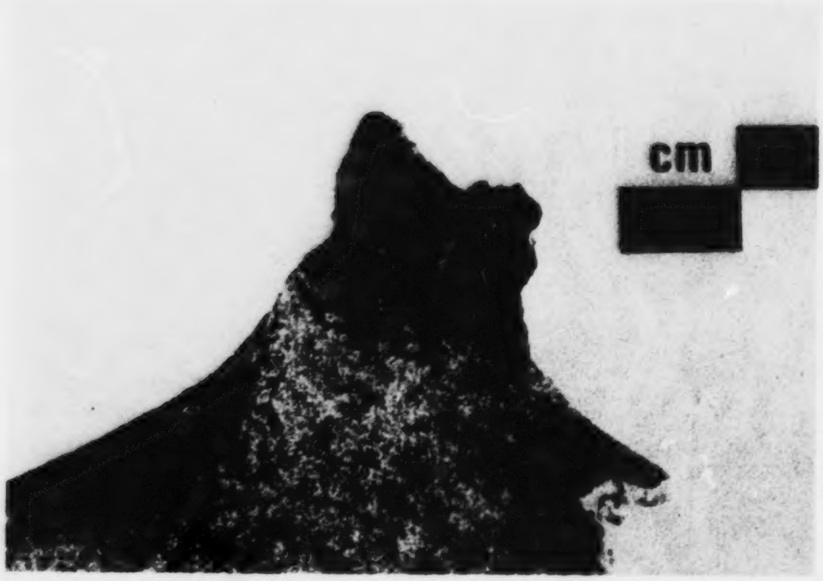


Figure 59. Closeup of incisions on deer antler rack portion.

Historic Remains

A variety of historic materials were recovered from the surface and near-surface deposits of the block excavation unit. These include a large number of fragments from a metal can that were distributed over four 2 m^2 units. The morphology of the can's rim suggests that it is quite recent in origin (Figure 60). The tip portion of a knife blade was recovered from the initial 10 cm level of a 2 m^2 within the block excavation, and it too is thought to be fairly recent in origin (Figure 60).

Remains which were likely contemporaneous with the most recent use of the jump site are present in the form of six blue glass trade beads (Figure 61). Three of the beads have been exposed to heat and this has substantially altered the appearance of the specimens (Figure 61, top row). One bead is actually melted while the other two are only glazed and retain their circular shape. Both beads measure 7.5 mm in diameter. Two of the remaining specimens are notably smaller with diameters of 5.1 and 4.3 mm, and lengths of 3.8 and 3.7 mm, respectively. The last specimen is a tubular blue bead measuring 2.4 mm in length and 2.5 mm in diameter (Figure 61).

Ceramics

As in previous years, the 1984 ceramic assemblage from HSI proved to be extremely fragmentary and, for all intents and purposes, largely unanalysable. There were only two analysable rim sherds in the collection and one of these was from a vessel believed to be made by a juvenile. The decoration on the latter sherd is relatively ornate, consisting of fine notches along the lip below which occur a band of tiny punctates above two horizontally incised lines which are separated by vertical notches. Further decoration occurred below this motif in the form of a single incised horizontal line, below which was a row of vertical notches (Figure 62). The other rim sherd is slightly incurvate in profile and not decorated except for a single vertical notch on the interior lip edge measuring 6.4 mm in length and 3.2 mm in width.

The remaining assemblage consists of a plain body sherd, a neck sherd with a cord wrapped stick impression and several hundred unidentifiable vessel portions, all of which are less than 2 cm in maximum dimension and

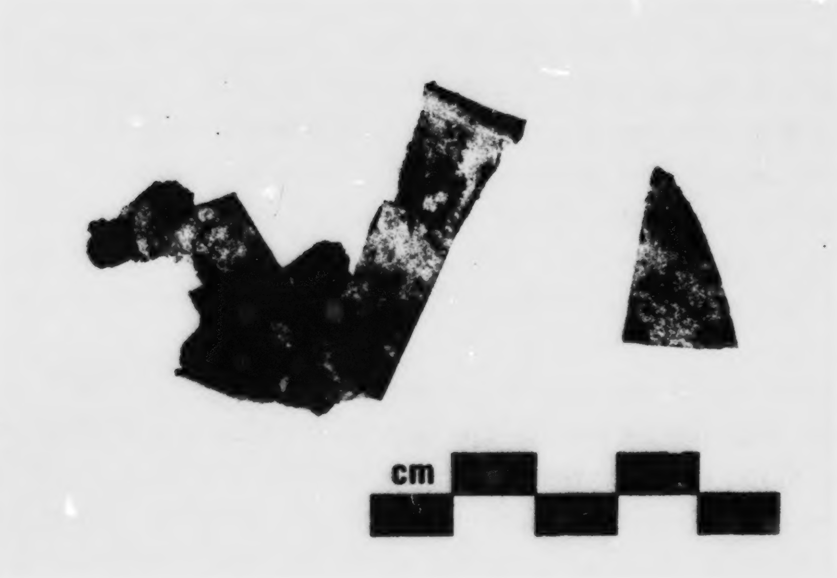


Figure 60. Metal artifacts.

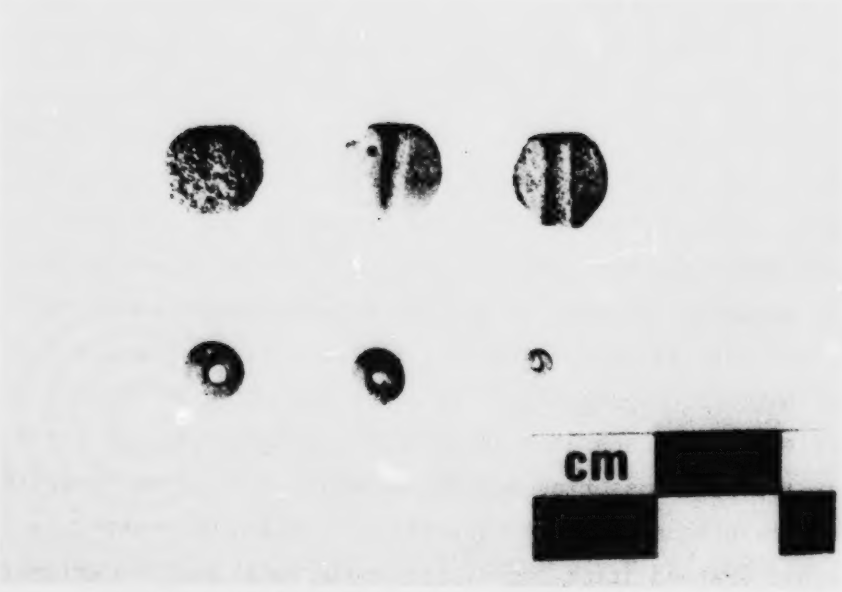


Figure 61. Blue glass trade beads.

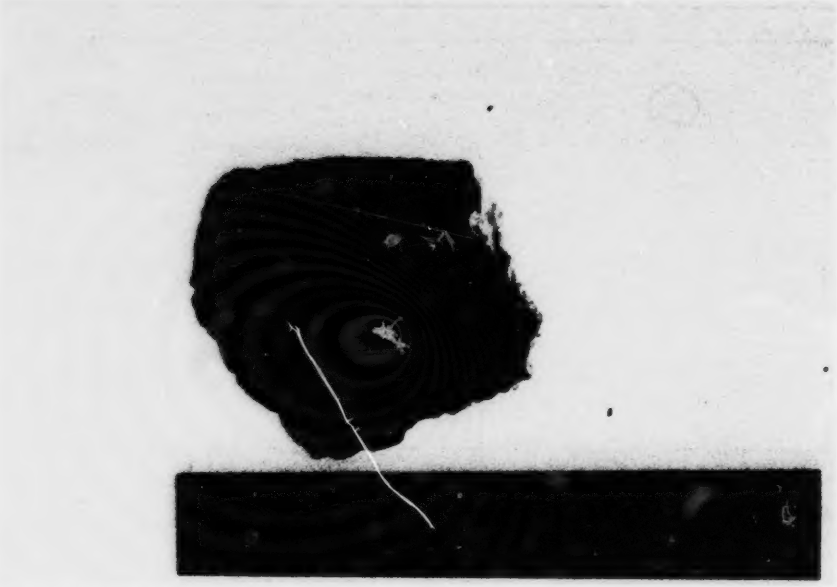


Figure 62. Ceramic rim fragment, Area 12.

weigh less than a gram. The majority of the ceramic remains recovered from the block excavation are felt to be the result of in situ fragmentation of larger vessel portions due to trampling and weathering. Because a count of fragments was clearly an inappropriate means of quantifying the assemblage, an alternative method which measured the distribution of the sherds was adopted.

By projecting the weight of sherds recovered over the exavation unit, it was possible to identify those areas that may have been the original location of the larger pieces that were subsequently fractured and partially dispersed. The resultant distribution illustrates that two areas within the block excavation unit are producing the majority of the ceramic fragments (Figure 63). The concentrations occur outside, and along the margin of, the possible tent ring structure, but no other associations can be extracted from these distributions.

Technological analyses of some of the Head-Smashed-In ceramics has been completed, and the results of these studies are presented in Appendix 2. The long term objective of this analysis is to characterize the range of variation of the HSI ceramics and compare this to local clay sources and other prehistoric sites in the area, particularly the Oldman River valley. In this way, it is hoped that some appreciation of the

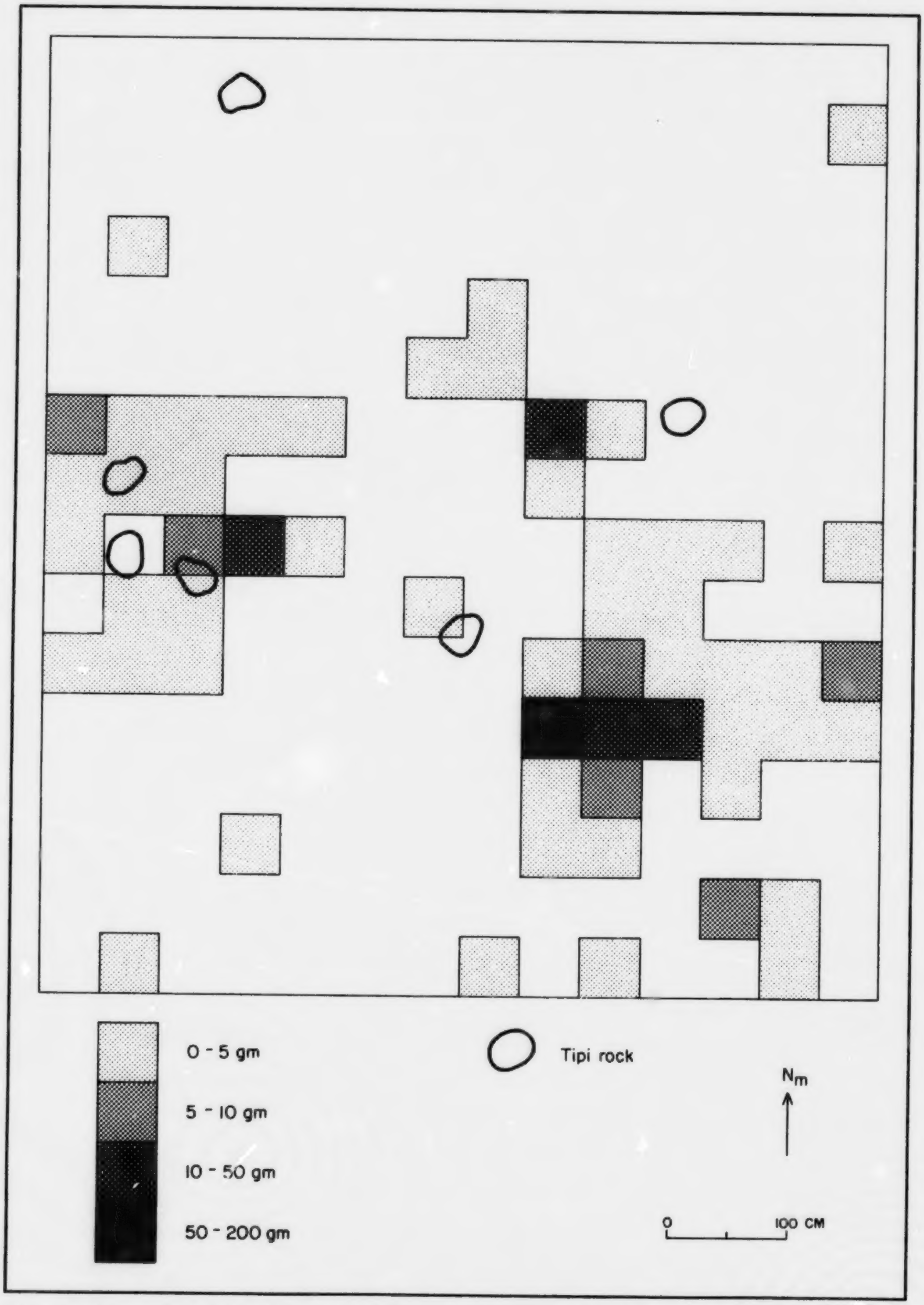

0 - 5 gm
5 - 10 gm
10 - 50 gm
50 - 200 gm
Tipi rock
Nm
0
100 CM

Figure 63. Density distribution of ceramic remains in the block excavation.

settlement/subsistence round can be obtained based on the distribution of similarly manufactured ceramic remains from local prehistoric sites (Hanna 1982). We suspect, for example, that ceramics were rarely, if ever, manufactured at the HSI site given the lack of local clays, minimal supplies of wood fuel and commitment of time and labour to the preparation and successful completion of the driving and butchering events. It seems likely that the ceramic vessels could have been used in the preparation of individual meals but, given their relatively small size, they are unlikely to have been used in communal processing activities.

Fire Broken Rock

Much of the HSI camp and processing site is covered with a dense layer of fire broken rock (FBR) that extends from surface to a maximum depth of 30 cm. This pavement of FBR is presumably the residue of many individual occupations which have been subsequently compacted by trampling and deflation. In our previous field season, the distribution of FBR was recorded on plan maps, the total weight of stone was noted and the material types tabulated. The results of that analysis indicated that most of the FBR was small (i.e., less than 10 cm in maximum dimension), and that most of the stone was imported to the site (Brink et al. 1985). This latter discovery was of some importance because, although the locally abundant sandstone was employed, it was certainly not the preferred material, suggesting that some property of this stone made it inferior to non-sandstone materials.

The relatively small size of the FBR specimens and the fact that most of this material was imported a distance of at least 1 to 2 km suggested that conservation and recycling of FBR was probably undertaken at HSI. We also suspected that the density and distribution of FBR probably varied over the camp and processing site and that this might reflect both intra-site settlement patterning and the spatial distribution of specific processing activities. These once discrete patterning areas are likely to have been partially obscured by successive occupations and recycling of the larger portions of FBR, but the association of discarded FBR and features used as boiling and roasting pits should still be discernable. Unfortunately, the widely dispersed test units that were completed in 1983 did not allow for the evaluation of such spatial patterning, although they did provide a general impression of the distribution and density of FBR over the site area.

The core area of the site revealed the densest concentrations of FBR, but these were also the most heavily utilized and, hence, most disturbed deposits. Once again, the peripheral areas were seen to produce the most promising locations for the identification of intact FBR deposits, which in turn are thought to be a reflection of specific processing events at HSI. In order to discover these discrete areas, part of our excavation and recording methodology included the piece plotting of all large (i.e., greater than 5 cm) FBR pieces. Because this size classification was judgementally applied by each crew member, some pieces smaller than 5 cm were drawn and collected, while other crew members tended to err by underestimating the size of the FBR fragments. As a result, the piece plot maps had to be interpreted with caution, both because the size depicted was sometimes incorrect, and because the spatial perspective of the recorders was found to vary substantially.

In some cases the abundance or scarcity of specimens would influence the recording procedure. That is, if FBR was abundant, the small fragments would tend to be passed over in favour of drawing the larger fragments, whereas if only a few small fragments were discovered in a subquad, it is likely that they would all be drawn and retained despite their small size (i.e., less than 5 cm). These discrepancies do not compromise the utility of the 1984 FBR data, but they do indicate the practical problems which can arise when applying lab generated methodologies to the field setting.

The block excavation yielded a total of 6611 pieces of FBR with a total weight of 423.6 kg (Table 4). These totals do not include the FBR from features which were discussed previously. The predominance of non-sandstone materials is graphically illustrated in Figure 64 which compares the counts and weights of non-sandstone and sandstone rock. The vast majority of non-sandstone FBR is quartzite, with minor quantities of other lithologies including basalts, granites and limestones. As noted earlier, these rocks do not occur in the immediate site area and had to be imported a distance of 1 to 2 km, either from a reworked till deposit in a glacial lake bed directly east of the site or from coulees leading up from the Oldman River valley (K. Hardie pers. comm. 1984).

Table 4. Fire broken rock from the block excavation.

	Non-sandstone	Sandstone	Total
n	5617	994	6611
%	84.9	15.0	99.9
Wgt	372.3 kg	51.3 kg	423.6 kg
%	87.9	12.1	100.0

Although sandstone materials are immediately available on-site, they were used only sparingly. Experimentation with sandstone for purposes of stone boiling suggests that the excessive amounts of water absorbed by this porous rock and its tendency to release grit make it inferior to other rock types (see Chapter 5). It is quite likely that the majority of the heat treated sandstone was not used for stone boiling, but rather as hearth linings or as a heat source for pit roasting (Lowie 1954:26; Wissler 1910:25). The nature of the heat discolouration associated with the sandstone is somewhat supportive of the latter supposition, for a wide range of oxidation is evident, extending from a light pink discolouration to a deep red. The reddening is a function of iron oxidization within the sandstone and is directly related to the intensity and duration of heat exposure.

If we are correct in assuming that sandstone was rarely, if ever, used for stone boiling and given that the raw resource is available in abundance, it is unlikely that sandstone would be recycled and repeatedly reheated. This would account for the minimal heat discolouration and the discontinuous nature of heat treating on individual specimens. Non-sandstone specimens are, on the other hand, likely to have been recycled several times, given that they are an imported resource and the preferred raw material. We would predict, therefore, that the absolute size of the non-sandstone pieces would probably be quite small due to repeated usage and resultant fracture. The tabular nature of sandstone suggests that it should be longer and thinner than non-sandstone pieces. Thus, the sandstone should be less fragmented and relatively larger in size, yet this is not the case.

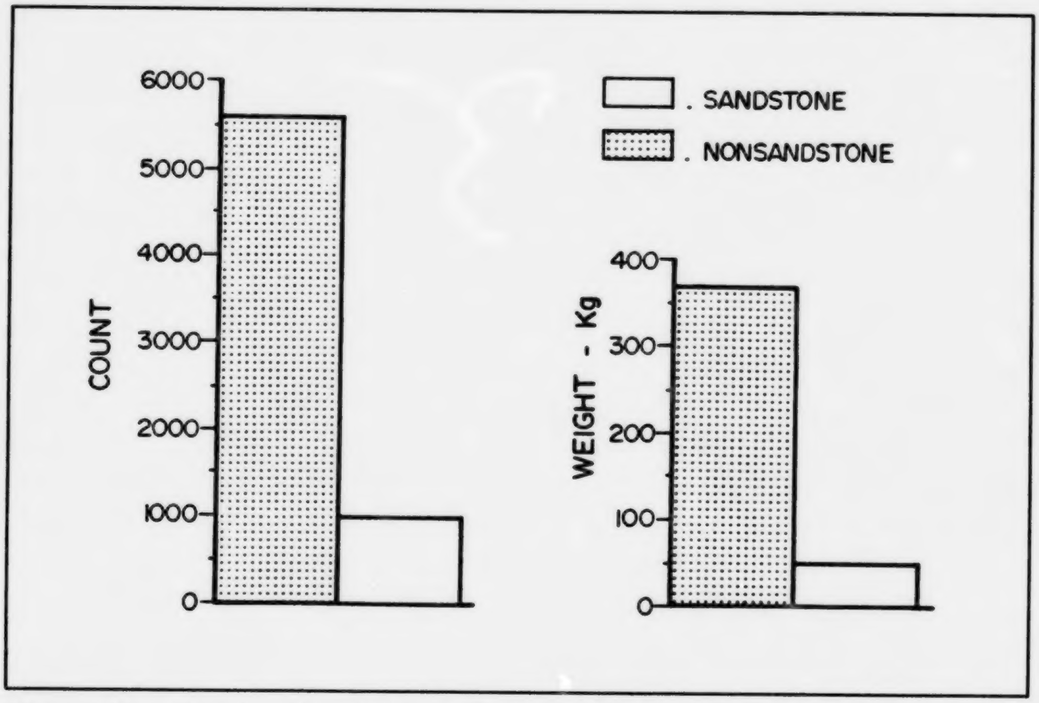


Figure 64. Count and weight of FBR by material type from the block excavation.

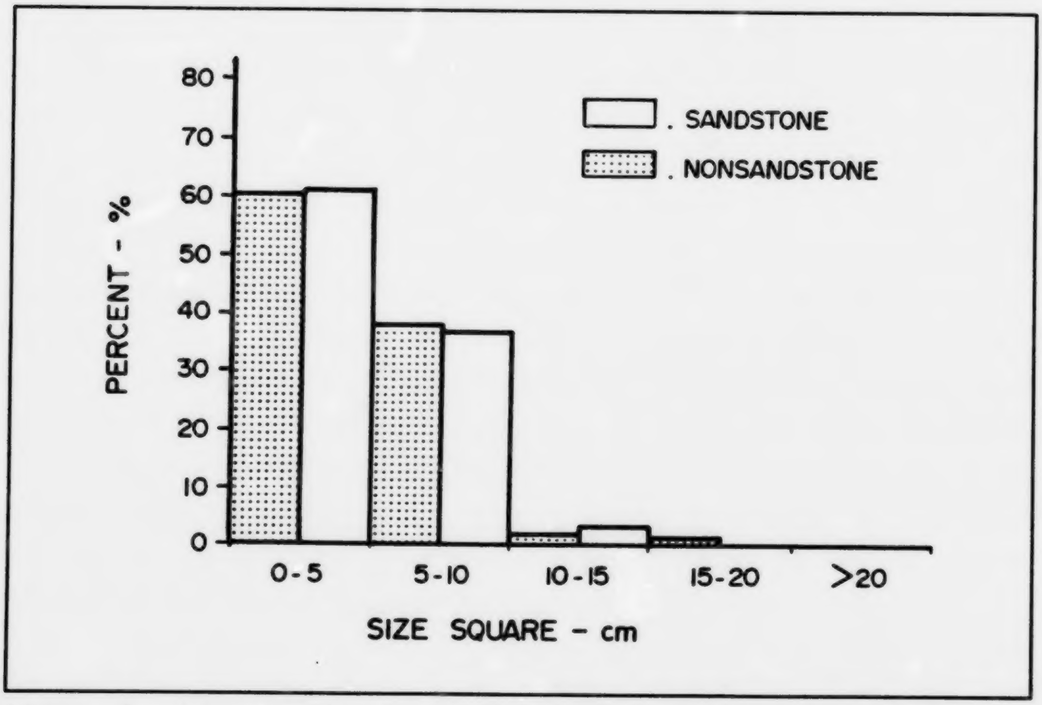


Figure 65. Size distribution of FBR by material type from the block excavation.

The size characteristics of the two material types are presented in Figure 65, where it is evident that both assemblages reveal nearby identical size fractions. The only logical explanation for this situation resides in the post-depositional agencies that affect the HSI deposits. Because the camp and processing site was repeatedly occupied and traversed by grazing ungulates, a significant amount of trampling and compaction has occurred. The friable nature of the tabular sandstone material is enhanced by heat treatment, because the calcite cementing material is chemically altered and water is driven off leaving empty pore space within the rock. If such a weakened, tabular shape is subject to trampling by both animals and man, it is predictable that fracture and overall assemblage down-sizing would occur.

The close correspondence in the size categories of the two materials is therefore probably fortuitous and partly an artifact of the arbitrary size categories used by this study. It is unlikely that the non-sandstone specimens were substantially altered by trampling, given their relative hardness, their cuboid shape, and their already small size at the time of deposition. The majority of non-sandstone fragments are less than 5 cm in size, and this does not include the small fragments which were discarded in the backdirt. Presumably, there is a point when the size of the rock makes it impractical to continue to recycle the resource. This critical size is probably dependent on a number of variables, including the task performed (i.e., stone boiling or roasting), the kinds of fuel employed and, probably most importantly, the availability of the raw resource.

At HSI, the distance to the source of the raw material was likely the most important variable, and one which no doubt promoted the recycling of resources and the adoption of a much smaller critical size at which point the rock could no longer be "efficiently" heated. Several of the pits yielded substantially larger pieces of FBR than were recovered in non-pit contexts. Presumably, the rock within the pits was still being recycled given the fact that none were whole but all were much larger than the rock recovered outside of the pit. Figure 66 presents a comparison of the size of fire broken rock from a pit feature with that of a non-pit assemblage. While the majority of non-pit specimens are 5 cm or less in size, the pit assemblage is 10 cm or larger in size. The burial, or at least partial burial, of these larger rocks in a subsurface pit context would make them less visible (i.e., less accessible), and hence more likely to be overlooked when recycling the resource. It is tempting to suggest that the 5 cm size may represent the discard threshold at HSI, but this cannot be fully substantiated without additional data. Such data include the distribution of FBR fragments over the block excavation based upon count, fragment size and material type. These distributions should also be correlated with feature distributions in order to identify the location of specific processing events. For example, we would predict that significant concentrations of FBR are likely to be associated with boiling pits, whereas roasting pits would not promote such concentrations. The size of rock fragments associated with stone boiling pits is likely to be smaller than rock from roasting pits because of the increased incidence of thermal stress associated with boiling stone technology. The evidence for these discrete processing deposits is discussed at length in the section of the report dealing with spatial patterning of remains within the block excavation.

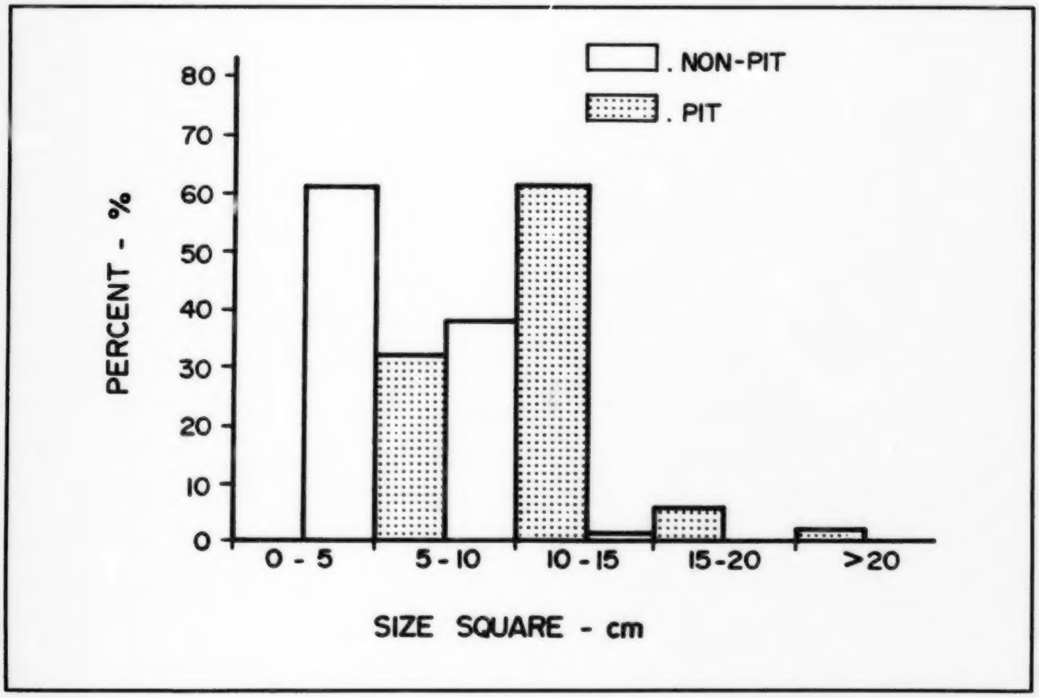


Figure 66. Size distribution of FBR from pit and non-pit contexts.

Lithics

Introduction

The lithic assemblage recovered during the 1984 field season at HSI consists of 19,328 flaked stone artifacts and associated debitage and 11 ground or unmodified stone tools. The flaked stone assemblage includes 18,217 pieces of debitage, 277 cores, and 834 tools and tool fragments including 268 projectile points.

This assemblage is quite similar to that recovered during the 1983 field season (Brink et al. 1985), notably in terms of the nature and relative proportions of raw materials, reduction stages, and functional categories represented. With a few exceptions, the range of temporally diagnostic artifacts is similar and reflects a dominance of Late Prehistoric types. Once again, the bulk of the lithic material was recovered from the upper 20 cm of a compressed and often disturbed context lacking any clear stratigraphy. The majority of the cultural material was recovered from the large block excavation in area 2 and the nearby unit 24, with the remainder (n=288 - 1.5%) recovered from area 12 excavations.

The methodology used here is an abbreviated version of that detailed in the 1983 field season report (Brink et al. 1985). For a comprehensive understanding of discrete attributes and methods employed, that document should be consulted.

The focus of the analysis of lithic material recovered during the 1983 season was a quantification of the assemblage as a whole. Particular emphasis was placed on describing the tool assemblage and comparing its constituent typological traits with those recovered previously at HSI and at other northwestern plains bison kill sites. Given the similarity of the assemblage recovered during the 1984 season to that of 1983, a duplication of the descriptive component of this analysis was considered superfluous when other important aspects of the assemblage were left wanting evaluation. For example, two results of the 1983 analysis were not consistent with our expectations:

1. There is good representation of all stages of lithic reduction complemented by a relatively large number of cores, particularly bipolar split pebble cores.

2. There is a notable lack of large formed butchering tools. To address these problems specifically, and to glean a more holistic understanding of the assemblage in general, a thorough examination of the debitage was deemed necessary, as this component of the assemblage was only given a precursory examination in the 1983 analysis. Accordingly, the debitage analysis will form the major thrust of the 1984 lithic analysis. This analysis will be presented after a brief description of tools and cores recovered during the 1984 field season at HSI. Any shortcomings in the detail of the following descriptive summary of the tools and cores are a consequence of the intentional bias towards the debitage analysis.

Flaked Stone Tools

1) Projectile Points

A total of 268 projectile points were recovered during the 1984 field season at HSI. In order to simplify description of these, the sample has been organized and is presented according to morphological types. Considerable difficulty was encountered with the typological grouping of the projectile points. This was due to a number of factors, including:

1. a lack of stratigraphic control;
2. poor bilateral symmetry on most of the specimens;
3. the fragmentary condition of many of these specimens; and,
4. numerous discordant classificatory schemes used by various authors (cf. Brink et al. 1985:105, 106).

A fundamental problem arises with trying to type this kind of assemblage using prescribed typological formulae, as these are based on using attribute states which often fail to account for the factors responsible for this variability. It is doubtful if any typology can satisfy stylistic, functional, idiosyncratic, raw material, and temporal variability.

The following summaries are not intended to be used as a comprehensive description of the projectile points nor as an outline of the parameters of these provisional types, but merely as a guide to attribute trends. Discrete measures and observations of the projectile points are provided in Appendix 3. The majority of the projectile points were recovered from the top 20 cm in the block excavation and nearby unit

24 in area 2 (n=256 - 95.5%). Where peculiar derivations from this occurred, they are noted in the text.

i) Plains Side Notched (Figures 67, 68, 69, 70, 71 and 72) n=15

These are generally well made with side notches placed relatively high on the body forming proximal-lateral edges between the notch and base. These correspond to the Plains Side Notched types as described by Kehoe (1966, 1973) and the Nanton, Pekisko, Paskapoo, and Washita varieties of the Old Women's Phase as described by Forbis (1962, 1977).

Raw Material:	chert (6), Swan River Chert (SRC) (2), chalcedony (1), obsidian (1), silicified wood (1), silicified siltstone (1), silicified sandstone (2), and fine argillite (1).
Integrity:	complete (4), base only (5), lateral segment (2), tip and part of base missing (2), tip missing (1), part of base missing only (1).
Blank Type:	Flaking has removed all cortex on these and only three have remnants of a single bulbar surface on one face. No particular blank type or orientation could be discerned.
Flaking:	This is generally well executed. One specimen (#40564) has neat, narrow, parallel transverse flaking directed from both edges on one face, and from the left edge on the opposite (obverse) face lending a triangular cross section to this artifact. Flaking on the other specimens is non-patterned or irregular.
Blade Edges:	In plan view, these are straight (8), convex (2), proximally skewed convex (1), or distally skewed convex (1), and most are slightly sinuous (7) in profile, are even and curve longitudinally (4), or in one case, straight and even.
Shoulders:	obtuse angular (9), obtuse rounded (4), square angular (1), or acute angular (1).
Notches:	rounded V-shaped (6), parabolic (4), U-shaped (3), rectangular (1), angular (1), or irregular (1). These are oriented either transversely (20), or oblique and trending proximally (3). Notching is accomplished by bilateral bifacial flaking (4), unifacial and bilateral

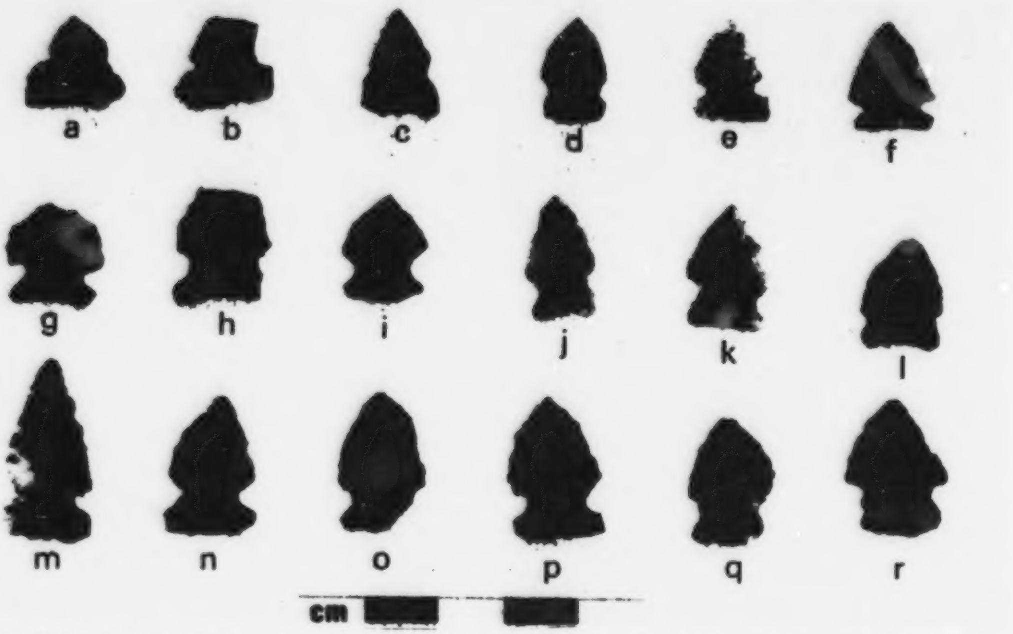
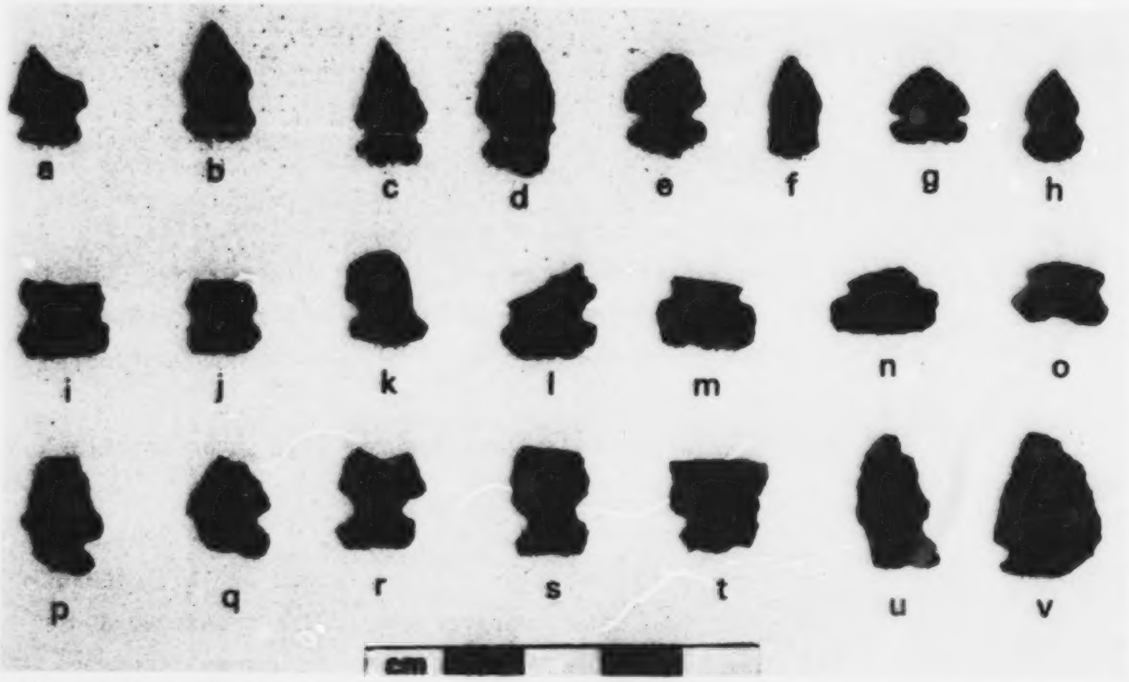

a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
q
r
cm

Figure 67. Projectile points. Small Notched: a-d, f-k, o, q, r; Plains Side Notched: e, m, n, p; Avonlea Type 1: l; Avonlea Type 2: g.


a
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v
cm

Figure 68. Projectile points. Small Notched: a-e, g-l, o-v; Small Stemmed: f; Plains Side Notched: m,n.

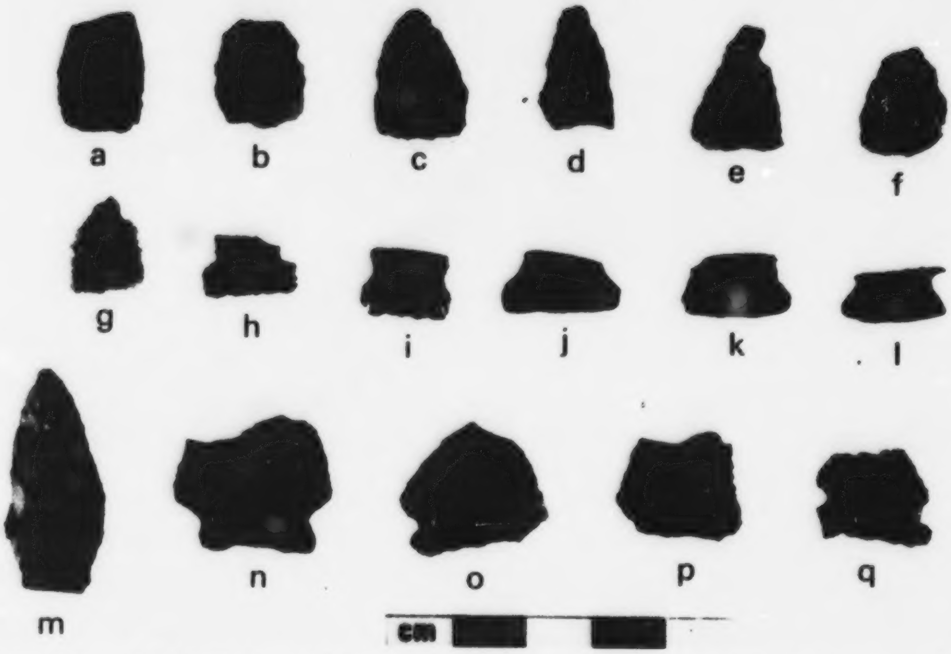

Figure 69. Projectile points and point preforms. Triangular: a-g; Plains Side Notched: h; Small Notched: i; Non-classified Atlatl: j, k, n, o, q; Pelican Lake: l; Narrow Ovate: m; Non-classified midsection: p.

Figure 70. Projectile points. Pelican lake: a, h, i, j; Concave Based: b, k, l; Non-classified Atlatl: c; Plains Side Notched: d; Small Notched: e, f; Narrow Ovate: g.

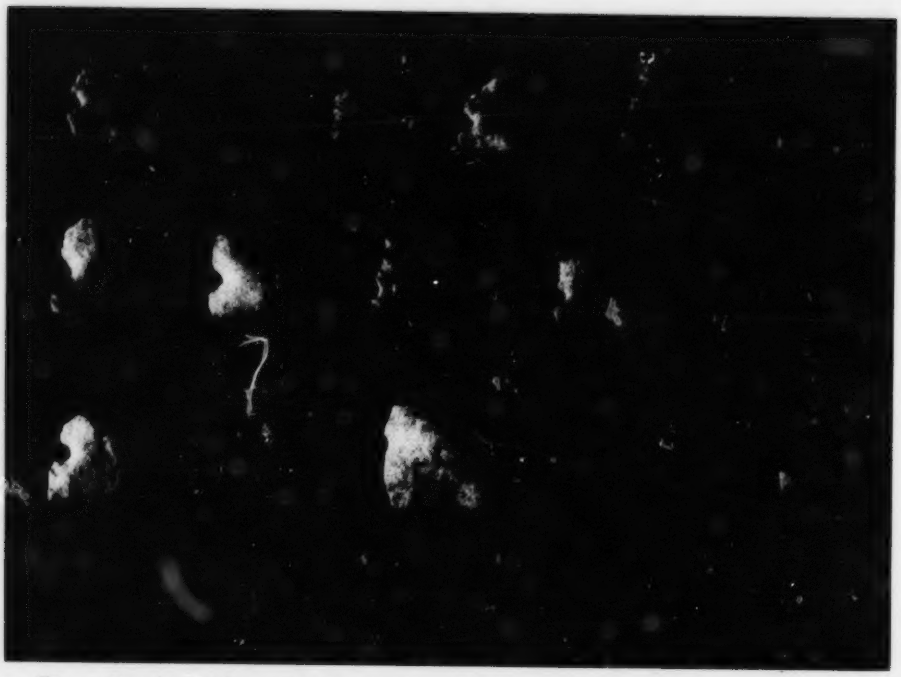

Figure 71. Projectile points and point preforms. Plains Side Notched: a, g, h, l; Small Stemmed: b; Small Notched: c-f, k; Avonlea Type 1: i, j; Triangular: m-p.

Figure 72. Projectile points. Plains Side Notched: a, g, i; Small Notched: b, d, f, h, j-m; Avonlea Type 1: c; Non-classified Atlatl: e; Non-classified blades: n, o.

(4), alternate unifacial right (3) or alternate unifacial left (2).

Proximal-Lateral Edge: Most are parallel to the longitudinal axis (13), or contract proximally (8), expand proximally (1), or form slightly rounded rectangular tabs (3).

Base: Bases are mostly straight (9), slightly concave (4), and one specimen (#43327, figure 70d) is basally notched by means of a small bifacially executed U-shaped notch in the middle of the otherwise straight base. This latter artifact is similar to that described by Kehoe as the Emigrant basal-notched variety (Kehoe 1973). On the other specimens, thinning is poorly expressed and is usually marginal and bifacial (8), marginal unifacial (1) or extensive and marginal with multiple scars (2).

Edge Grinding: Three have grinding on the base edge only and one has grinding on the base and stem.

Use Wear and Tip Morphology: Tips, where present, are sharp (4). Breakage on these specimens is apparently use related or is a result of post-depositional damage; manufacture faults are not apparent. No use wear is observable.

ii) Small Notched (Figures 67, 68, 69, 70, 71 and 72) n=59

This heterogeneous category represents all side and corner notched specimens in the arrowpoint size range which could not be classified as either Avonlea or Plains Side Notched. The more conventional typological labels which could be applied to most of these include the Prairie Side Notched type of Kehoe (1966, 1973), the High River, Lewis, and Irvine variants of Forbis' Old Women's Phase (1962, 1977) and the Samantha Side Notched type described by Reeves (1983a). Due to problems associated with typing this assemblage, it is likely that some aberrant Plains Side Notched or poor examples of Avonlea points may be included. The authors make no pretense to suggest that these small notched points represent a de facto type but rather are an ad hoc grouping designed to facilitate description.

Raw Material:	chert (21), chalcedony (6), obsidian (6), silicified siltstone (6), silicified wood (5), Knife River Flint (KRF) (4), SRC (3), quartzite (3), silicified sandstone (2), fine argillite (2), and porcellanite (1).
Integrity:	complete (17), bases only (18), distal tip and part of blade missing (8), distal tip missing (7), tip and part of base missing (5), or a portion of the base missing only (4).
Blank Type:	Four of these were formed by marginally bifacially retouching a thin flake and both flake faces are represented; one point is extensively flaked on one face only with a bulbar surface on the opposite side, and two artifacts were made on decortication flakes. Otherwise, details of blanks are obscured by flaking and no cortex is present. On six specimens, the blank orientation was observable: three flake points had the platform at the proximal end, two at the distal end, and one at the proximal lateral corner.
Flaking:	Flaking was indistinct or non-patterned on most of these specimens with no particular flake scar morphology or orientation, although one KRF specimen (#44273, figure 67k) has neat, parallel sided flake scars oriented obliquely. The workmanship is highly variable, often poor, and bilateral symmetry is poorly expressed.
Blade Edges:	mostly straight, sharp and even (17) or slightly sinuous (24). Ten edges curve in longitudinal section and are either double bevelled (6) or single bevelled (4), four are straight and form a single bevel, and one chalcedony specimen (#27882, figure 68c) has serrated edges. Edges are straight (29), convex (15), proximally skewed convex (7), irregular (2), or distally skewed convex (1) in plan view.
Shoulders:	Most are obtuse angular (39) or obtuse and rounded (22); six are acute and rounded, three are barbed, three are square, and one is square and rounded.

Notches:	mostly parabolic (32), or irregular (13); otherwise, these are angular (8), crescentic (8), V-shaped (7), or in the case of one particularly small specimen (#33786, figure 68g) U-shaped (2). Notch orientation is most frequently transverse (87), or tends to be slightly directed from the corners (6). The notching technique was observed to be alternate unifacial right (11), alternate unifacial left (11), bifacial and bilateral (10), unifacial and bilateral (8), bifacial and unifacial (2), or unifacial and unilateral (1).
Proximal-Lateral Junctures:	These tend to be poorly developed but form crude proximal lateral tabs in 56 cases which either contract (23), are parallel (16); expand proximally (4), or form rounded tabs (16); otherwise, these junctures are angular (19), eared (5), sharp (4), or blunt (4) with no proximal lateral edges.
Base:	most often straight (34), concave (9), convex (5), or irregular (4). Thinning is poorly developed and often occurs as marginal bifacial retouch (27), marginal unifacial retouch (9), or extensive and marginal with multiple scars (1).
Edge Grinding:	This occurs on both the bases and stem (8), on the base only (5), on the stem edges only (5), on the notches and the base (2), on the notches only (1), or on the stem, base, and shoulders (1). Seven specimens were not ground.
Use Wear and Tip Morphology:	Tips were complete and sharp (12), snapped off (10), blunt (7), truncated on a flat fracture (6), rounded (2), or impact fractured (5). Three artifacts were used for tasks other than projectile points; one specimen (#28743, figure 67f) has been worn and rounded on one lateral edge, and two identical specimens (#37581 and #37833, figure 67a and 67b, respectively) have been resharpened to the point where the blades are only short triangular

stubs which have been nibbled, suggesting use as gravers or spokeshaves.

Heat Alteration: Two specimens have discolouration attributed to heat, one KRF specimen has a lustre attributed to thermal pretreatment (#44273, figure 67k), one artifact has a discolouration and lustre associated with thermal pretreatment, and two artifacts have been heat damaged.

Remarks: Although these points are heterogeneous, three pairs of small notched points were recovered which appear similar enough that they can be considered discrete varieties. These pairs are quite different; one pair consists of the reworked specimens described above (#37581 and #37833, figures 67a and 67b) which have nearly identical outline morphologies, use wear, flaking technique including the treatment of bases and notches, both are made of a dark red lustrous chert or jasper, and were found in the same excavation unit. The other two pairs of nearly identical points include two expanding based asymmetrical silicified wood specimens which are each missing one ear (#38830 and #39782, figures 68u and 68d) and were recovered from the same excavation unit; and two straight based narrow points with broad side notches (#30004 and #39209, figures 68r and 68s), with snapped off tips, made of siliceous siltstone, and recovered from adjacent units. The points in each of these pairs are similar enough that they could have been manufactured and used by the same craftsman. Such typological similarity was not observed between other small notched projectile points made of disparate raw materials.

iii) Avonlea Type 1 (Figures 67l, 71i, j and 72c) n=4

These are the distinctively well made arrowpoint with obtuse shoulders and notches placed close to the base. They represent the "classic" variety referred to by Reeves (1983b) as Timber Ridge Side Notched.

Raw Material: All are chert.

Integrity: Two are missing most of the blade and one ear, one is missing the base and the distal tip, and one is virtually complete except for a small portion of the tip.

Blank Type: One specimen (#45948, figure 72c) was formed by alternately unifacially retouching a thin flake with the platform oriented distally; otherwise, these are completely bifacially flaked and no cortex is present.

Flaking: non-patterned, but neat, narrow, parallel sided, shallow flake scars on three specimens including the flake point; the almost complete specimen is somewhat less aesthetically pleasing with shallow, variable, non-patterned flake scars.

Blade Edges: Two specimens have slightly convex edges, two have straight edges. The edges are very shallow angled and sharp, and are either straight and even (2), straight and slightly sinuous (2), or, in the case of the flake point, these are even but curve in longitudinal section (2).

Shoulders: obtuse angled and sharp.

Notches: These have a variable morphology, either parabolic (1), angular (1), crescentic (1), or V-shaped (1). These are transversely oriented and are formed alternately unifacially right (2) or bifacially and bilateral (1).

Proximal-Lateral Edges: Two specimens have sharp angled ears which are either distally contracting or are parallel to the long axis. One specimen has angular ears.

Base: All are concave with marginal bifacial thinning.

Edge Grinding: One has a heavily ground base and stem, one has a non-ground but blunt base and a ground stem (proximal-lateral edge), and the almost complete specimen is not ground.

Use Wear and Tip Morphology: A minute portion of the tip on one specimen is snapped off; otherwise, the tips are absent. No wear is discernable.

Heat Alteration: The flake point has very lustrous flake scars suggestive of thermal pretreatment; otherwise, no heat alteration is apparent.

Distribution: One specimen (#46247, figure 71i) was recovered from feature 9 in area 12; otherwise, these were excavated from the block excavation in area 2.

iv) Avonlea Type 2 (Figure 67g) n=1

This specimen, although somewhat more robust than the Type 1 specimens described above, has the morphology and workmanship characteristic of the Avonlea type. The notches, however, are directed from the corners, which is an attribute peculiar to the Head-Smashed-In variant described by Reeves (1983b).

Raw Material: silicified mudstone.

Integrity: distal tip and part of blade missing.

Flaking: well executed. Due to the incomplete condition of this artifact, flaking morphology is largely indeterminate.

Blade Edges: indeterminate.

Shoulders: Both are square, one is slightly barbed and the other is slightly broken and has a blunt appearance.

Notches: One is V-shaped and one parabolic, oriented obliquely towards the distal end.

Proximal-Lateral Edges: These occur as minimally modified angular tabs with short proximally contracting proximal-lateral edges.

Base: slightly concave. Thinning is poorly expressed and occurs as minimal marginal bifacial retouch.

Edge Grinding: The stem edges and base are heavily ground. Longitudinal striations are visible on the base and proximal-lateral edges. Transverse striations are visible on the lower notch edges and the insides of the notches are polished, presumably from haft wear.

Heat Alteration: not apparent.

v) Triangular (Figures 69a-g and 71m-p) n=18

These are relatively heterogeneous in terms of raw material and morphology but share dimensions and workmanship suggestive of projectile points. The lack of notching, use wear, or grinding, indicates that these are an unfinished stage of projectile point manufacture.

Raw Material: Most of these are chert (10) including two of SRC, two are fine argillite, two are quartzite, and one each of silicified mudstone, silicified wood, silicified siltstone and chalcedony.

Integrity: Three are complete, otherwise, the tip is missing (6), the blade is missing (6), both the tip and part of the base are missing (2), and on one, part of the base is missing.

Blank Type: Most of these are completely bifacially flaked, obscuring all detail of the blank. Two specimens retain a small cortical surface and the silicified mudstone specimen has a largely unmodified bulbar surface on one face. No particular blank orientation for these could be inferred.

Flaking: Workmanship on these is highly variable but the finer materials exhibit fine craftsmanship. No particular flaking pattern or orientation is evident.

Blade Edges: In plan view, these appear straight (4), convex (10), proximally skewed convex (7), distally skewed convex (1). In profile, edges are straight and even (8), curved and even (10), curved with a single bevel (2), curved with a double bevel (1), or irregular (1).

Base: Base edges are predominantly straight (13), or are concave (4) or irregular (1). The bases were thinned by means of marginal bifacial retouch in most cases (12), four exhibit extensive unifacial thinning, one has marginal unifacial thinning only, and one exhibits a single extensive flake on one face and multiple marginal thinning on the opposite face.

Edge Grinding: No grinding is apparent.

Use Wear and Tip Morphology: No use wear is apparent. Only one has a well formed sharp tip, four have poorly formed blunt tips, eight are missing tips on a flat truncation,and four tips have been snapped off. No impact fractures were observed.

Heat Alteration: One specimen is extensively crazed, and one quartzite specimen has a pinkish cast attributed to heat; otherwise no evidence of heat alteration is apparent.

Remarks: Due to the lack of use wear, impact fractures, grinding, or facility for hafting, these cannot be considered finished projectile points, but their morphology leaves little doubt as to the intended function. Triangular "projectile points" have a widespread distribution and their occurrence in processing areas associated with bison kill sites can hardly be considered uncommon (cf. Fredlund 1981). Interestingly both Frison (1973) and Fredlund (1981) not only suggest that these are projectile point preforms, but they assume that the occurrence of these indicates on-site projectile point manufacture. For example, Frison suggests at Wardell, "Considerable manufacture of projectile points is suggested by forty-three probable projectile point blanks", and he indicated that these have no use wear or notching but some are "broken at various stages of completion" (Frison 1973:64). Recent evidence at HSI suggests that although on site manufacture may be represented, some preforms are imported to the site and may represent the form by which some exotic materials were obtained. The implications posed by this hypothesis on projectile point typologies are the subject of a paper to be presented at a later date.

vi) Pelican Lake (Figures 691, 70a, h, i, and j) n=5

These are corner notched points in the atlatl dart point size range.

Raw Material: One each of SRC (#30324), mudstone (#30717), Kootenay Argillite (#43737), silicified mudstone (#45803), and chalcedony (#46158).

Integrity: The argillite specimen has a longitudinally snapped off shoulder. The mudstone specimen was complete but was so soft when excavated that a blade edge and the tip were accidentally rubbed off. The other three specimens are obliquely truncated, removing the blade and one shoulder on two specimens and most of both shoulders on the silicified mudstone artifact.

Blank Type: The chalcedony artifact was formed by marginal bifacial retouch on a patinated biplanar flake; otherwise, these have no cortex. The other four have been completely bifacially flaked removing all blank characteristics.

Flaking: Flaking is indeterminate on the three broken specimens but the remnant portions display excellent workmanship. The Kootenay Argillite specimen is asymmetrical and although completely bifacially flaked, the flaking is crudely executed with no particular orientation or flake morphology. The mudstone specimen is well made; the flaking on the blade, where it has not been obliterated, has neat parallel flake scars obliquely oriented, almost parallel to the long axis.

Blade Edges: The argillite specimen has very irregular but sharp angled blade edges. The remnant blade edge on the mudstone specimen is straight, even, and sharp.

Shoulders: The tip of the shoulder on the chalcedony specimen is broken; otherwise, this would have been slightly barbed. The other shoulders are approximately square although oriented obliquely and away from the base.

Notches: These are directed from the corners and are either parabolic (4) or crescentic (1). The notching technique is either unifacial bilateral (2), alternate unifacial right (2), or alternate unifacial left (1).

Proximal-Lateral Edges: All form acute angles and are either blunt (the argillite and SRC specimens), or sharp.

Base: These are either straight (3) or very slightly convex (2). Basal thinning is marginal bifacial (3), single extensive and marginal (1), or multiple extensive and marginal (1).

Edge Grinding: On the chalcedony and mudstone specimens, grinding is restricted to the base edge; on the other three, grinding occurs on the base and stem.

Use Wear and Tip Morphology: The tip of the argillite specimen is dulled from a small impact fracture; otherwise, no wear is apparent.

Heat Alteration: none apparent.

Distribution:
30324, 30717: area 2, unit 24, level 1
43737: area 2, unit 34, level 1
45803: area 2, unit 38, level 1
46158: area 12, unit 8, level 3

Remarks: The stratigraphic position of the chalcedony specimen (#46158, figure 70i) poses some problems, as a date derived from bone at a depth of approximately 20 cm deeper in the same one metre square quadrant (470±150 years B.P. [AECV 62c]) is certainly too recent to date this artifact. The occurrence of the other four specimens in level 1 in area 2, often stratigraphically superimposed on typologically later materials, illustrates both the compressed and somewhat disturbed nature of these deposits. The occurrence of a Pelican Lake point of Kootenay Argillite (#43737, figure 70h) is consistent with the results of Reeves who observed that this material was well represented at HSI in kill deposits during that time period (Reeves 1978, 1983b).

vii) Concave Based (Figures 70b, k and l) n=4

These share the common characteristic of having no notches, parallel proximal margins, and have concave bases. These are probably dart points.

Raw Material: SRC (#39512), quartz (#45500), chert (#45806), and quartzite (#47251).

Integrity: All are missing the tip and much of the blade; two (#45806 and #47251) are missing a portion of one ear.

Blank Type: The chert specimen was made by marginal bifacial retouch on a biplanar flake; otherwise, bifacial retouch covers both faces and no cortex or blank orientation is evident.

Flaking: Due to their fragmentary condition, no discernable flake pattern or distinctive morphology is apparent; however all are well made.

Blade Edges: largely indeterminate but appear to have been relatively straight, even, and sharp, probably curving convexly towards the tip at a point distal to the fractures on these specimens.

Proximal-Lateral Junctures: The quartz specimen has sharp, acute angled, almost square, proximally trending junctures; the other three specimens have rounded, distally trending ears.

Base: All have concave bases; three are marginally bifacially thinned and the quartzite specimen is bifacially thinned with a large broad flake scar on one face and several marginal scars on the opposite.

Edge Grinding: none apparent.

Use Wear and Tip Morphology: Tips are absent; no other use wear is evident.

Heat Alteration: The chert specimen has a reddish colouration attributed to heat.

Remarks: The quartzite specimen (#47251, figure 70k) was recovered from a pit feature in the block excavation in area 2. A date derived from bone in this feature of 2710±150 years B.P. (AECV 60c) indicates that this artifact is at least that old. This may represent a McKean lanceolate base and, if so, the date would not be discordant with other northern plains occurrences of this type (cf. Saylor 1979). It is also interesting to note that the other concave based points were all recovered from level 2 in the block excavation.

viii) Narrow Ovate (Figures 69m and 70g) n=2

These have thick biconvex cross sections, with convex blade edges leading from a straight base to the tip.

Raw Material: fine argillite (#46063) and SRC (#41154).

Integrity: A thin section of a proximal blade edge is missing on the SRC specimen; otherwise, these are complete.

Blank Type: indeterminate. Bifacial flaking extends across most of both faces and no cortex is present.

Flaking: irregular and non-patterned. The SRC specimen has one edge formed unifacially.

Blade Edges: Even and straight in profile, the angles on these are relatively steep.

Shoulders: n/a

Notches: The argillite specimen has been alternate unifacially retouched to form two very slight concavities adjacent to the base, lending a slight constriction to the proximal end; otherwise, these have no formed stems.

Proximal-Lateral Junctures: angular and slightly obtuse on the SRC specimen, angular and square on the other.

Base: Both are straight. Thinning on the argillite specimen occurs as a single broad flake scar extending on either face to the midpoint. The SRC artifact has a single thinning scar extending about a quarter of the length distally from the base on one face, and on the opposite face, a pair of very long thinning flakes extend distally to an indistinct terminus. No other retouch occurs on the base of either of these artifacts.

Edge Grinding: The argillite specimen has a heavily ground base edge with linear striations apparent; the other specimen is not ground.

Use Wear and
Tip Morphology: A very small portion of the distal tip of the argillite specimen is missing. Neither tip is sharp. Smoothening of the proximal high points on the argillite specimen may indicate haft wear.

Heat
Alteration: none apparent

Distribution: #41154: area 2, unit 31, level 1
#46063: area 12, unit 5, level 4

ix) Small Stemmed (Figures 68f and 71b) n=2

These are very small arrowheads with approximately square stems and triangular blades.

Raw Material: Silicified wood and KRF

Integrity: Both are complete.

Blank Type: The KRF specimen is a thin marginally retouched flake; the other specimen is bifacially flaked, removing blank characteristics.

Flaking: non-patterned

Blade Edges: sharp, slightly serrated, and straight. The KRF specimen curves in longitudinal section due to the curvature of the flake.

Shoulders: The KRF specimen has one sharp, obtuse angled shoulder; otherwise, the shoulders on both of these represent the juncture where reprofiling of the edge discriminates the stem from the blade.

Notches: The KRF specimen has a very slight unifacial notch on one edge; otherwise, these are notchless.

Proximal-Lateral
Junctures: These are square on the silicified wood specimen and blunt obtuse on the KRF specimen.

Base: The silicified wood specimen has a slightly convex, marginally bifacially thinned base; the KRF specimen has a straight unmodified base.

Edge Grinding: none apparent

Use Wear and
Tip Morphology: Both tips are sharp; no wear is apparent.

Heat Alteration: The silicified wood specimen has a partial reddish discolouration attributed to heat.

x) Non-classified Atlatl Points (Figures 69j, k, n, o, q, 70c and 72e) n=8

Eight artifacts could not be classified due to their peculiar morphology or incomplete state, but the size range represented by these specimens indicates they were likely portions of dart points.

Raw Material: Chert (4), KRF (1), silicified siltstone (1), silicified mudstone (1), and porcellanite (1).

Integrity: One chert specimen (#30722, figure 69o) is missing most of the base; otherwise, these are all missing tips and either most (3) or all of the blade (4).

Blank Type: One chert base (#40882, figure 70c) retains a portion of a bulbar surface on one face; otherwise, these are completely bifacially flaked, removing all cortex and blank characteristics.

Flaking: No particular flaking morphology or orientation was observed. The KRF specimen is particularly well formed.

Blade Edges: The blade on the one distally intact specimen (#30722, figure 69o) has straight slightly convex blade edges which are very even and sharp. This blade appears to have been resharpened to give this artifact a very squat planform. Blade edges on the other specimens are largely absent.

Shoulders: Those specimens with intact shoulders (4) all have obtuse angled shoulders which are slightly rounded.

Notches: Two chert specimens have small, rounded, U-shaped to parabolic notches placed close to the base (#34629, #30722, figures 69q and 69o, respectively), the silicified siltstone specimen (#44808) has a single shallow parabolic notch placed close to the base, the porcellanite specimen has very broad parabolic to V-shaped notches placed very close to the base, and one chert stem (#40882, figure 70c) has very broad shallow notches almost lending a stemmed appearance to this specimen. The notching technique was unifacial and bilateral (4), alternate unifacial right (2), or unifacial unilateral (1).

Proximal-Lateral Junctures: These occur as slightly acute blunt junctures (1), rounded laterally projecting tabs (2), a contracting proximal lateral edge (1), and on the KRF specimen short, approximately parallel, proximal-lateral edges.

Base: These are all approximately straight, although the porcellanite specimen is slightly concave and the silicified mudstone base is slightly convex. Thinning occurs as marginal bifacial retouch (2), multiple extensive and marginal retouch (2), or in one instance, extensive unifacial retouch with multiple scars.

Edge Grinding: Grinding occurred on the base only (3), or on both the base and stem (2), where observable.

Use Wear and Tip Morphology: No use wear was observed. The one intact tip is very obtuse angled, probably due to extensive resharpening, but is sharp.

Remarks: Stratigraphy provided no clue as to the age of these artifacts. All were recovered from area 2; six were excavated from level 1 in the block excavation, one from level 2 (#40882), and one from unit 24 level 1 (#30722). The KRF specimen (#30849, figure 69j) may be attributable to the Besant phase, although the neck is rather narrow; otherwise, no cultural affiliation could be posited for these.

xi) Miscellaneous Non-Classified Projectile Point Fragments (Figures 69p 72n, and o) n=150

These could not be classified due to a lack of diagnostic attributes. Fragments represented include tips (44), blades (12), midsections (17), base fragments (24), lateral segments (14), and non-classifiable portions (39). These latter could not be oriented, although the morphology and workmanship suggest they are point fragments. Raw materials represented in these categories are described in Table 5.

2) Hafted Biface (Figure 74f) n=1

This small bifacially flaked chert specimen has the gross morphology of a projectile point but the distal end lacks a sharp tip. Both slightly convex lateral margins are considerably worn. Wear occurs as smoothing with a few longitudinal striations indicating use as a knife for cutting or sawing. The stem is formed with shallow unifacial side notches, the base is unmodified. A small chattermarked cortical surface indicates that this artifact was derived from a pebble.

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)	Stem Length	Edge Angle
38121	0.6	15.1	9.4	3.8	6.0	70°

3) Hafted Spokeshave/Gravers (Figures 73p, 74e) n=2

These are both made on small triangular flakes of Knife River Flint; one is fashioned from a side-struck flake (#46778), the other an end-struck flake (#44860). Marginal unifacial retouch extends onto the dorsal faces forming steep angled, straight to slightly convex and uneven lateral edges, triangular cross sections, and quite sharp tips. The larger specimen (#46778) has two shallow unifacial notches placed one third the distance distal from the base, but not altering the triangular planform. The smaller specimen has a stemmed appearance with shallow unifacial notches placed close to the base. The base on both of these is unmodified. No use wear is apparent. These are similar to two notched flake gravers described by Frison at Piney Creek (1967:6, 16).

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)	Stem Length	Edge Angle
44860	0.2	12.2	8.7	2.6	4.6	60°
46778	0.7	18.8	13.0	4.3	6.5	75°

Table 5. Frequency of raw materials represented by non-classifiable projectile point fragments.

	Tips	Blades	Mid-Sections	Bases	Lateral Segments	Non-Classifiable	TOTAL
Chert	20	3	9	10	6	17	65
SWC	4	3	2		3	4	16
Chalcedony	6	1		1	1	3	12
KRF	5	1	1	2	1	7	17
Quartzite			1	1	2	1	5
Obsidian	2		1	5		1	9
Silicified Wood	2	1		1		2	6
Silicified Siltstone	5		1	2	1	1	10
Silicified Mudstone		1		1			2
Silicified Sandstone			1			2	3
Fine Argillite			1				1
Kootenay Argillite						1	1
Porcellanite		1					1
Quartz				1			1
Fused Glass		1					1
Total	44	12	17	24	14	39	150

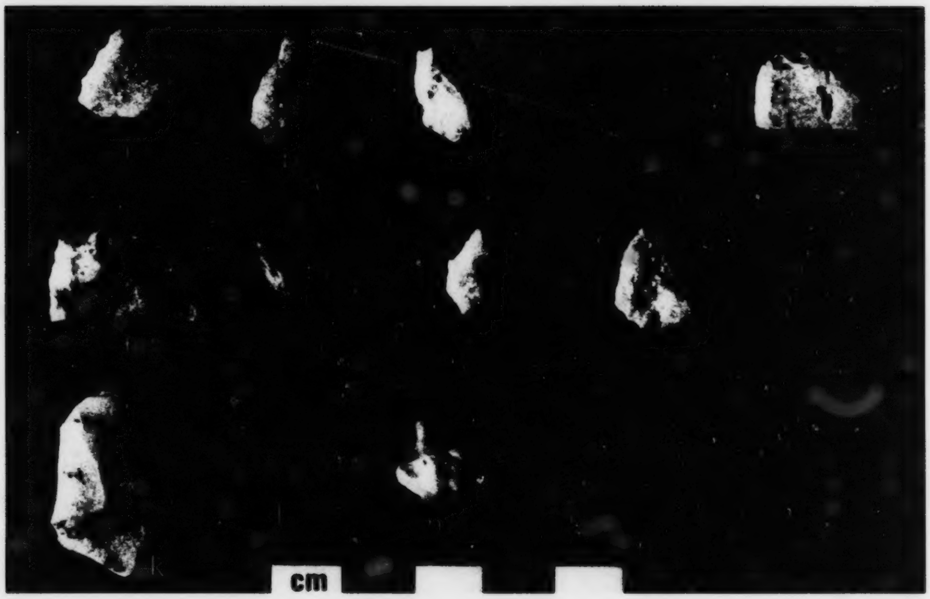

Figure 73. Miscellaneous flaked stone tools. Triangular flake tools: a, b, i, j, m, o; endscrapers c-f; eccentric: g; awl/borer: h; spokeshave: k; reamer: l; hafted spokeshave/graver: n.

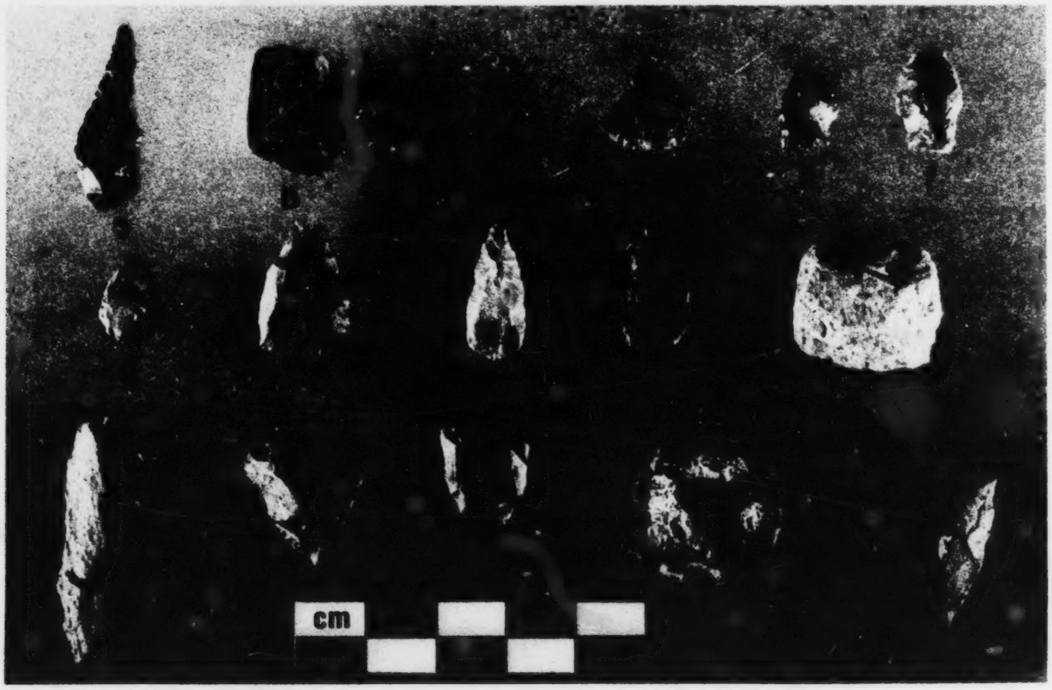

Figure 74. Miscellaneous flaked stone tools. Awl/borers: a-d; hafted spokeshave/graver: e; hafted biface: f; triangular flake tools: g, h, i, j; pièce esquillée: k; small ovoid biface: l, endscrapers: m-p.

4) Triangular Flake Tools (Figures 73a, b, i, j, m ,o, 74g, h, i, j and 75c) n=11

These are small artifacts with triangular to ovate planforms and biplanar to triangular cross sections with steep bilateral unifacial retouch, either on opposite faces (7) or restricted to one face (4). Two of the latter specimens were made on bipolar split pebble fragments, one of which retains a small cortical surface, and both were extensively unifacially flaked. The other specimens were made by marginally retouching a flake blank. Minute nibbling retouch on most of these specimens indicates they are tools rather than preforms, and they appear to have been used as scrapers or spokeshaves. Raw materials include Swan River Chert (2), Knife River Flint (2), other cherts (4), porcellanite (1), quartzite (1), and silicified mudstone (1).

	Minimum	Maximum	Mean
Weight (g)	0.3	1.3	0.5
Length (mm)	12.4	21.0	16.2
Width (mm)	8.8	15.1	11.6
Thickness (mm)	1.9	5.6	2.6

5) Drill (Figure 77f) n=1

This completely flaked artifact of Swan River Chert has a roughly triangular planform and a thick biconvex cross section almost diamond shaped at the bit. The convex base edge has been ground, suggesting this artifact was hafted. The tip of the bit is a short, smoothed, transverse edge, and the lateral margins of the bit are considerably rounded and exhibit transverse striations, indicating use.

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)
45048	1.4	20.3	13.8	5.6

6) Awls/Borers (Figures 73h and 74a-d) n=5

These are morphologically heterogeneous but share the common characteristic of either a formed (4) or utilized pointed projection. Three of the formed tools have a V-shaped bifacially retouched bit with a biconvex cross section and an unmodified flake butt. Raw materials of these three are obsidian, quartzite, and Swan River Chert. A second

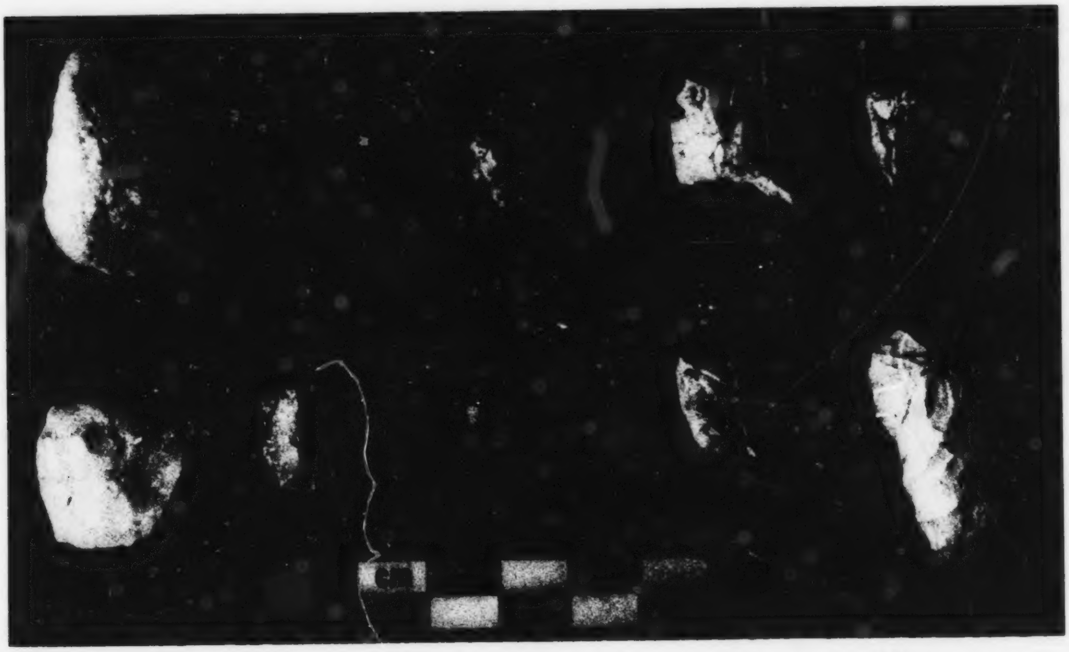

Figure 75. Miscellaneous flaked stone tools. Small ovoid biface: a; graver: b; triangular flake tool: c; endscrapers: d-j.

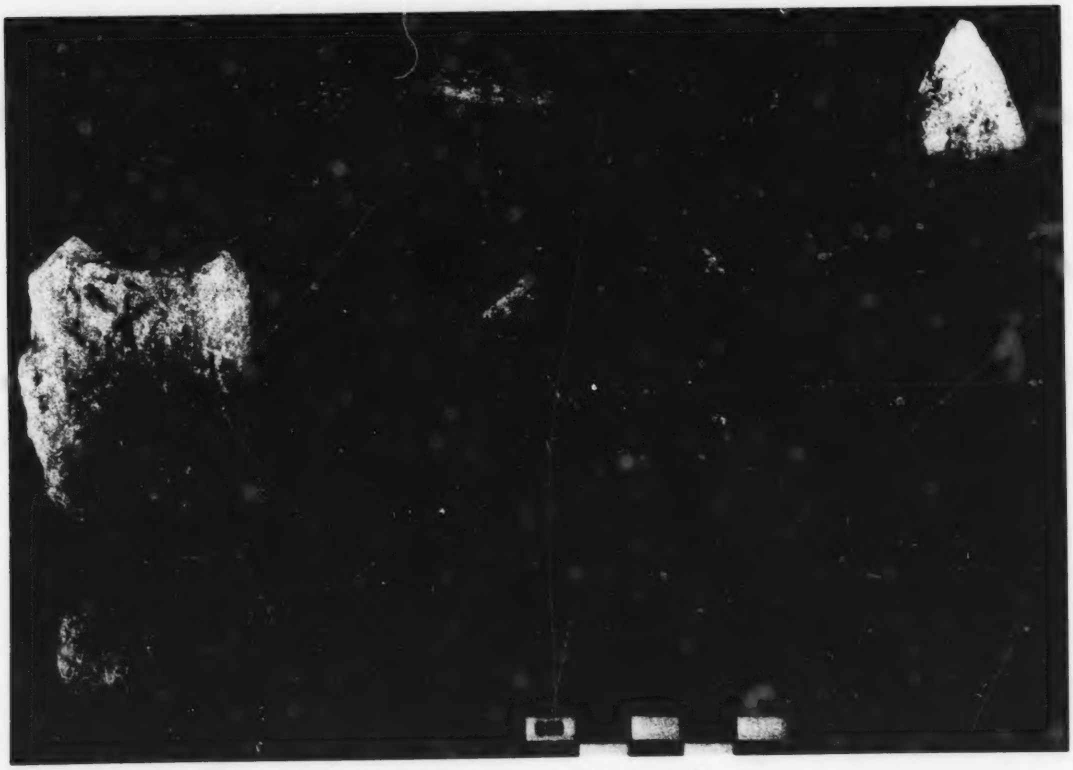

Figure 76. Large bifacial cutting/scraping tools.

obsidian specimen is elongate with a thick, roughly bifacially trimmed end tapering to a narrow tip with a triangular cross section. The bit is bifacially retouched on one margin and naturally backed with a flat facet. The tip is rounded from usage. The unmodified specimen is a thin, triangular, expanding flake of chalcedony with rounding on the proximal end and high points indicating use.

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)
28715	0.2	12.8	8.0	1.8
30851	0.4	14.1	12.5	2.9
40230	1.3	19.0	19.2	3.9
40803	1.2	26.2	10.0	5.8
44964	0.3	12.6	9.2	3.4

7) Pièce Esquillée (Figure 74k) n=1

This chert specimen has been completely bifacially flaked into a rectangular, almost square, form with an approximately biplanar cross section. The edges are blunt or crushed with numerous minute step terminated flake scars, apparently a result of use.

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)
40336	3.4	20.8	18.4	7.8

8) Endscrapers (Figures 73c-f, 74m-p and 75d-j) n=34

These appear to be exhausted tools which are either broken, worn out, or resharpened to the point that they could no longer be rejuvenated. Of the complete tools (21), eight are minimally modified expedient tools made by fashioning a convex edge with steep marginal unifacial retouch on either bipolar split pebble fragments (3), small oval flakes (3), a small thick spall (1), or a thick flake fragment (1). Most of the latter of these appear unsuitable for hafting. With the exception of an approximately square, quadrilaterally retouched specimen, the formed endscrapers have unifacially trimmed lateral margins which expand to a mildly convex single bevelled working edge. Where the blank type was observable, it was either an expanding flake (8) or a bipolar split pebble fragment (2). Of the thirteen formed endscrapers, five exhibit

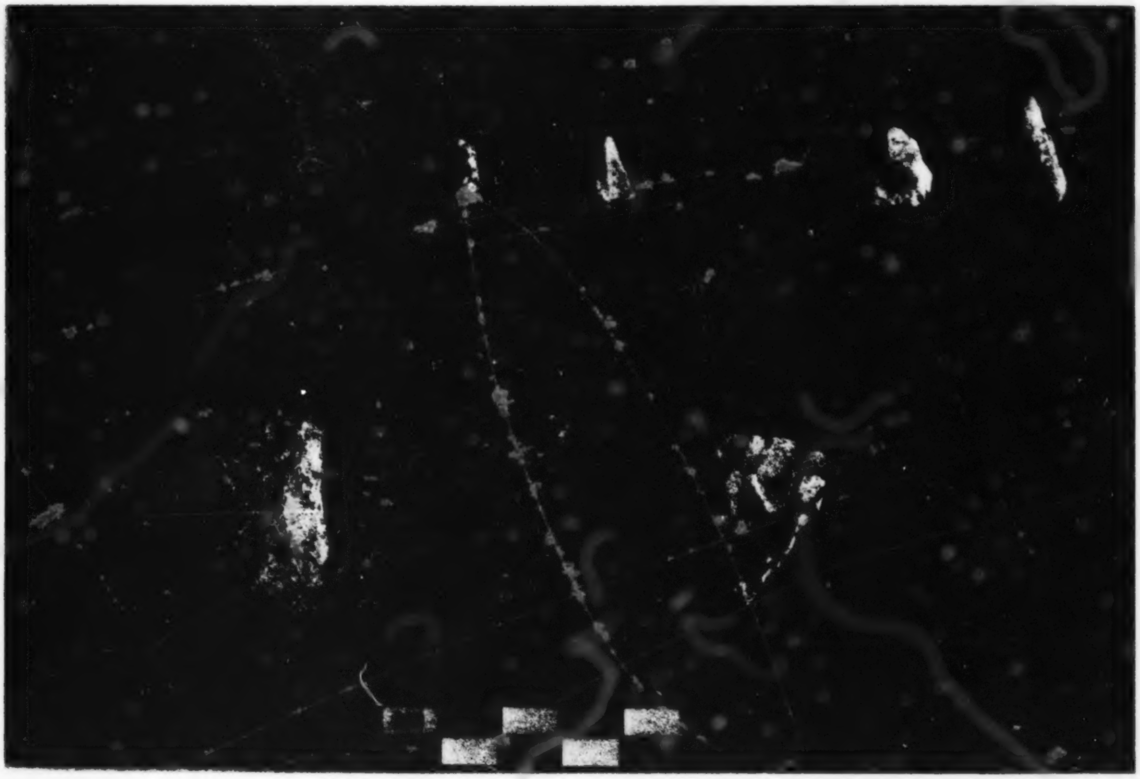

Figure 77. Miscellaneous flaked stone artifacts. Amorphous multiple platform core: a; bipolar cores: b-e; bifacial drill: f; sidescrapers: g-k.

marginal unifacial retouch, nine are dorsally finished, and one Knife River Flint specimen is bifacially formed.

This latter artifact (Figure 73d) is particularly interesting as it is quite small (Length: 12.5 mm, Width: 7.8 mm, Thickness: 2.9 mm). The planform is a teardrop shape and the cross section is plano-convex. As both lateral margins are ground, it appears that the tool was hafted. Use wear on this artifact occurs as nibbling retouch which has been partly removed from the middle of the bit by ventral rejuvenation. This specimen compares well with the microendscrapers described by Moe et al. (1978:119, Figure 28) from the Bootlegger Trail Site, a Late Prehistoric bison kill site in Montana.

The fragmentary endscrapers (13) include ten transversely snapped distal ends, two lateral halves, and a firebroken distal half. The snapped distal ends were probably broken off of hafted tools. Frison has observed that a fracture this close to the working edge on artifacts of this thickness would be hard to perpetrate without the leverage of a handle (Frison 1973:64). One of the endscraper fragments is a bipolar split pebble spall; otherwise, these are apparently flake tools with retouch on the distal flake margin (11) or at the proximal flake end (1). On all unifacially retouched endscrapers in the sample, retouch is onto the dorsal flake face.

On specimens where use wear was observable (31), unifacial nibbling retouch was present, accompanied by rounding of the edge (3), rounding with polish along a thin section of the edge (7), ventral microflaking (1), and one considerably worn specimen was worn to a flat facet with transverse striations and ventral microflaking. Raw materials represented in the endscraper category include: cherts (27), of which two are Swan River Chert; Knife River Flint (2); silicified mudstone (2); chalcedony (2); and quartzite (1).

	Minimum	Maximum	Mean	S.D.
Weight (g)	0.3	8.4	2.2	1.6
Length (mm)	12.5	33.8	21.0	5.7
Width (mm)	7.8	25.7	17.9	4.1
Thickness (mm)	2.4	10.4	6.1	1.9
Edge Angle	60	90	71.4	8.4

9) Reamers (Figures 73l and 78m) n=2

These artifacts have a morphology and use wear which suggests they were turned about their long axis during use. One of these (#38580) is a thin triangular Knife River Flint flake fragment which has even alternate unifacial nibbling retouch on both lateral margins. The second specimen, a relatively thick silicified mudstone decortication flake (#43138), has steep unifacial nibbling retouch which extends along one lateral edge to the tip which is quite rounded.

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)
38580	0.5	14.4	11.0	1.6
43138	6.9	42.6	24.0	8.5

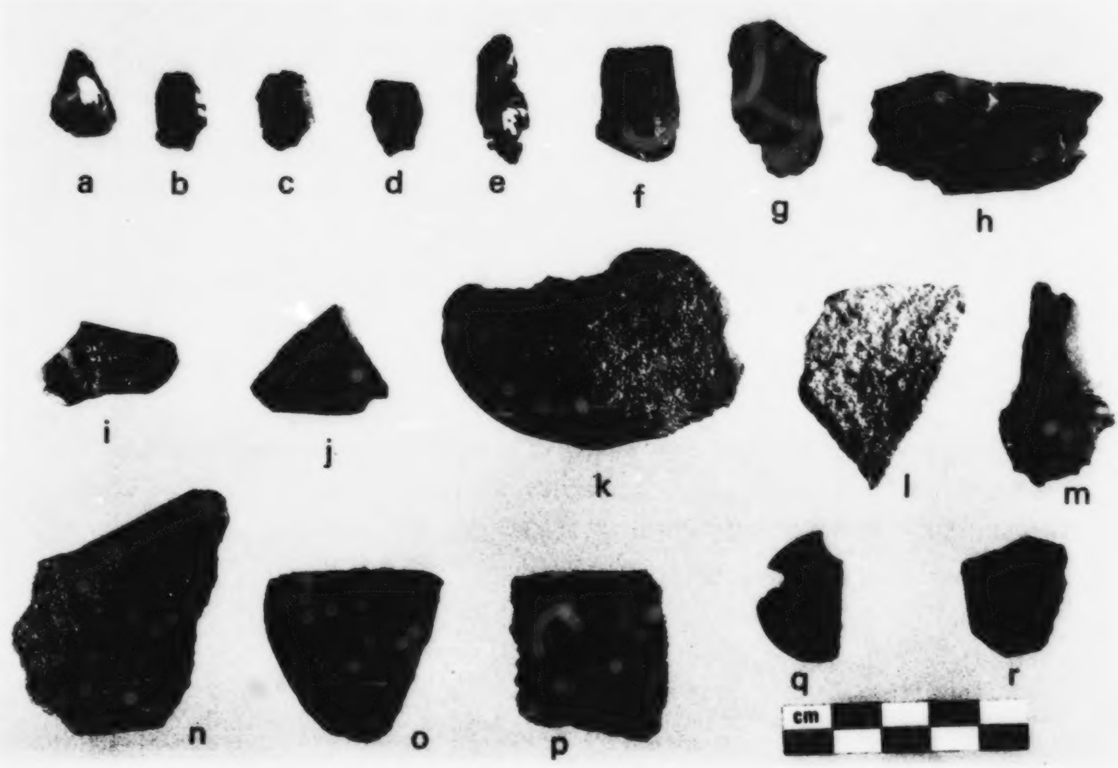

Figure 78. Miscellaneous flaked stone artifacts. Bipolar cores: a-h; marginally bifacially retouched tool fragment: i; edge ground flakes: j-l; reamer: m; sidescrapers: n-r.

10) Sidescrapers (Figures 77g-k and 78n-r) n=42

In this category, a broad range of raw materials and morphologies are represented. These share the common characteristics of having at least one unifacially retouched, long, mildly convex to straight lateral edge. Where the blank type could be determined, a flake was used in 16 cases, a bipolar split pebble was used in 10 instances, and seven are made on cortical spalls. Of the five specimens which were extensively unifacially flaked, three were bipolar split pebble fragments. Twenty-five of the sidescrapers are relatively complete, two are firebroken and potlidded; otherwise, they are represented by an edge fragment (7), or are missing an end (8). Raw materials include various cherts (17) including three of Swan River Chert, quartzite (8), silicified siltstone (5), Knife River Flint (3), argillite (3), chalcedony (2), and one each of obsidian, silicified mudstone, silicified sandstone, and silicified limestone.

	Minimum	Maximum	Mean
Weight (g)	0.3	282.1	19.4
Length (mm)	17.9	104.2	41.0
Width (mm)	12.0	81.8	31.0
Thickness (mm)	1.9	27.3	7.8
Edge Angle	40	85	61

11) Large Bifacial Cutting/Scraping Tools (Figure 76) n=13

This artifact category is represented by fragments only, including four transversely broken rectanguloid specimens, four pointed tips, four thick edge segments, and one midsection. Raw materials represented include quartzite (8), Swan River Chert (2), a patinated brown chalcedony (1), silicified lignite (1, KRF?), and a rose coloured chert (1). This latter chert specimen is finely flaked with sharp edges, a symmetrically biconvex cross section, and a sharp tip; otherwise, the workmanship on the other specimens can be described as fair. Most of these tools were formed by the removal of relatively large flakes, leaving very sinuous edges which are worn quite dull. The four rectanguloid specimens and one end each have a double and a single bevelled lateral edge, suggesting dual usage as both cutting and scraping tools.

	Minimum	Maximum
Weight (g)	0.7	59.8
Length (mm)	23.8	95.0
Width (mm)	12.0	47.4
Thickness (mm)	8.0	22.8

12) Edge Ground Flakes (Figures 78j-l and 79d-g) n=17

These are predominantly large flakes of locally available coarse grained materials, including argillite (12), quartzite (4), and basalt (1). Most of these artifacts are clearly from the initial stages of core reduction; only one lacks a cortical surface, three are spalls, and of the remainder, five have cortex platforms and a cortical dorsal terminus which indicates they are cobble sections. These artifacts are unmodified except for use wear which occurs as rounding and linear striations on either a single straight to slightly convex lateral or distal flake margin (12), or on two such margins (5). On two of these latter five specimens, a margin formed by the juncture of a cortex and a non-cortex face exhibited transverse striations; otherwise, the presumed functions of these implements are cutting and sawing. The wear on most of these was so well developed that the edges were actually flattened, lending a U-shaped profile to the edge.

This artifact category was not as well represented in the excavations conducted in the processing area in 1983, although one example is illustrated in Figure 52 (Brink et al. 1985). One speculative explanation for the apparent lack of these in what appears to be the most heavily utilized part of the processing area is that, as they are predominantly large flakes, the probability that they would be reused and further modified into other tools would be optimized. It would seem less likely that these on-site materials would be reworked in peripheral areas where reoccupation was not as frequent.

	Minimum	Maximum	Mean
Weight (g)	12.0	164.9	52.3
Length (mm)	45.6	100.7	55.2
Width (mm)	29.1	85.2	46.3
Thickness (mm)	9.4	27.0	15.6

13) Chopper/Chopping Tools (Figure 79a-c) n=6

These are relatively large, thick flake tools. Materials represented include argillite (3), quartzite (2), and limestone (1). With the exception of the limestone specimen, all of these have a cortex surface. The limestone artifact has a roughly biplanar cross section, and irregular discontinuous bifacial trim forms a rough edge which has been battered. One argillite flake and one quartzite spall fragment are unmodified except for a battered edge which occupies the thinnest edge on a wedge shaped cross section. The other quartzite chopper has a similar wedge shaped cross section with a crushed edge opposite a naturally backed cortex margin. The ventral face on this specimen is worn smooth in the middle, suggesting an alternate use as an abrading stone. The remaining two specimens of argillite have been pecked on a localized area of their cortex surfaces, indicating use as anvils. The smaller of these has been roughly bifacially flaked about most of the periphery; the other specimen has been heavily battered on one end and both lateral margins have been abraded.

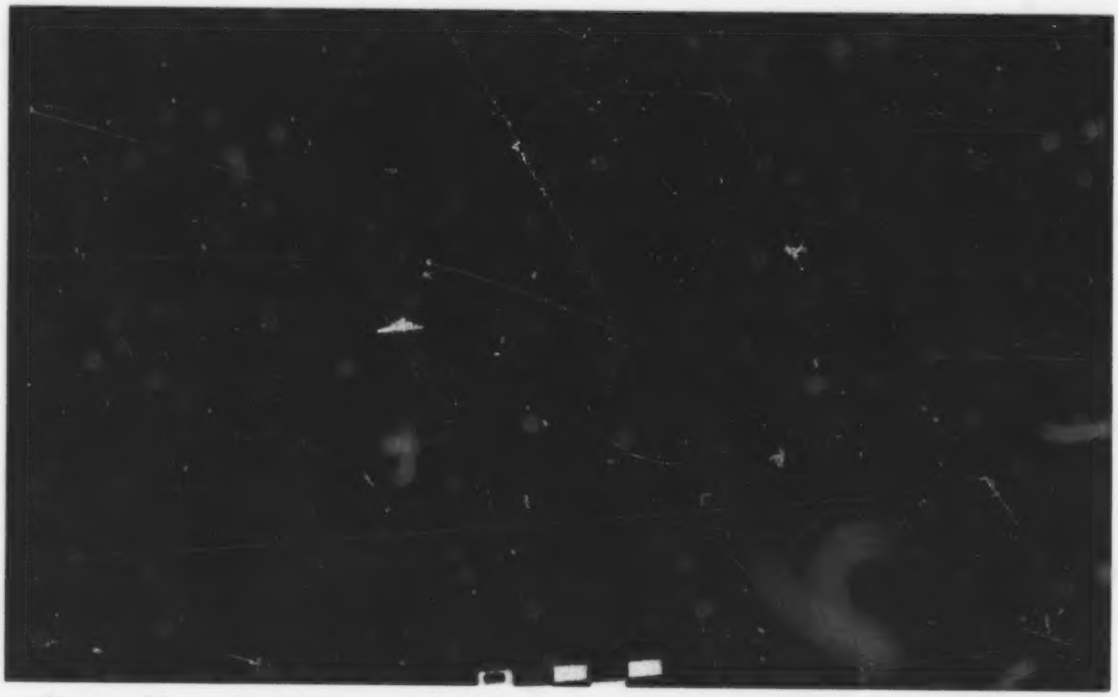

Figure 79. Miscellaneous flaked stone tools. Chopper/chopping tools: a-c; edge ground flakes: d-g.

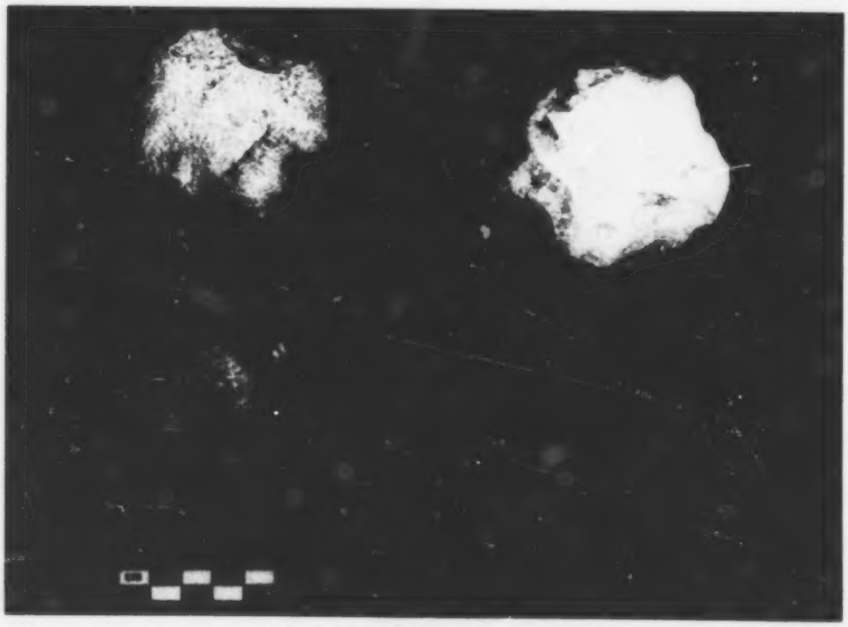

Figure 80. Amorphous multiple platform cores.

	Minimum	Maximum	Mean
Weight (g)	103.3	229.8	166.1
Length (mm)	80.3	110.6	94.0
Width (mm)	50.9	77.9	66.6
Thickness (mm)	18.5	34.4	25.8

14) Graver (Figure 75b) n=1

This chert artifact is a roughly triangular flake fragment with a biplanar cross section. At the tip of the pointed end occurs unifacial nibbling retouch and the extreme tip is quite rounded; otherwise, this artifact is unmodified.

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)
32714	2.7	34.2	16.3	5.0

15) Small Ovoid Bifaces (Figures 741, 75a) n=2

These small elongate specimens have a thick, biconvex cross section and are completely bifacially flaked, forming relatively steep angled sinuous edges about the periphery. Raw materials represented are silicified wood (#30991) and Swan River Chert (#46143). No use wear is evident. These artifacts appear to be the remnant nubbins of resharpened larger artifacts.

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)	Edge Angle
30991	4.2	36.7	15.2	6.8	75°
46143	6.0	35.0	19.0	7.4	70°

16) Spokeshaves (Figure 73k) n=6

These pieces of debitage are largely dissimilar except they share the common characteristic of having a concave portion of an edge which has been unidirectionally scraped on a hard surface. The utilized edge in five cases is unmodified other than the use wear which occurs as unifacial nibbling retouch forming an angle of about 80°. One artifact has been unifacially flaked to achieve a broad concave edge with an angle of 60°, but nibbling retouch has as well reprofiled the edge margins to an angle of about 80°. These spokeshaves have irregular planforms, varying from trilateral to pentagonal, with either thin, roughly biplanar cross sections (4) or thick, wedge-shaped cross sections (2). Raw materials include silicified sandstone (2), silicified siltstone (1), porcellanite (1), dendritic chert (1), and Swan River Chert (1).

	Minimum	Maximum	Mean
Weight (g)	1.1	13.0	6.5
Length (mm)	17.4	45.7	35.3
Width (mm)	17.4	36.0	25.1
Thickness (mm)	4.1	13.6	7.6

17) Miscellaneous Marginally Retouched and/or Utilized Flakes (Figure 78i) n=377

These are artifacts and artifact fragments that could not be neatly pigeonholed into any of the previous tool categories. They either have a single utilized margin (105), a single unifacially retouched edge (71), a single bifacially retouched edge (110), or have two or more utilized or retouched edges (91).

i) Single Utilized Edge Flakes n=105

These are characterized by discontinuous or irregular unilateral unifacial nibbling retouch. Only 38 of these can be regarded as approximately complete; otherwise, these are represented by portions of utilized edges (32), or are missing an end (35). Most of these are small, thin flakes or pieces of shatter with no cortical surface (64). Twenty are pieces of decortication flakes, seventeen are cortical spalls, and four are utilized flakes derived from bipolar split pebbles. Raw materials include chert (47), Swan River Chert (11), quartzite (10), silicified siltstone (8), Knife River Flint (7), silicified mudstone (6), obsidian (4), silicified wood (4), siltstone (2), chalcedony (2), silicified sandstone (1), argillite (1), sandstone (1), and mudstone (1).

	Minimum	Maximum	Mean	S.D.
Weight (g)	0.1	92.0	2.7	9.1
Length (mm)	15.1	76.0	29.1	12.3
Width (mm)	9.1	52.9	21.5	8.6
Thickness (mm)	1.3	27.1	4.9	3.2

ii) Single Unifacially Retouched Edge Tools n=71

These are represented by small, thin flakes or pieces of shatter with no cortex (54), decortication flakes (11), cortical spalls (5), and one bipolar split pebble fragment. Unilateral, marginal, unifacial retouch usually occurs on a straight to slightly convex or uneven edge. Twenty-nine are approximately complete, 26 are represented by an edge fragment, 11 are missing an end, and five are remnants of severely potlidded artifacts. Raw materials include various cherts (35) of which five are Swan River Chert, chalcedony (10), Knife River Flint (3), quartzite (9), obsidian (3), silicified siltstone (4), silicified wood (2), quartz (1), argillite (1), limestone (1), silicified limestone (1), and an unidentified fine grained material (1).

	Minimum	Maximum	Mean	S.D.
Weight (g)	0.1	89.4	3.0	11.2
Length (mm)	30.8	72.4	48.9	17.0
Width (mm)	17.2	47.7	31.2	11.7
Thickness (mm)	1.5	23.1	5.4	3.9
Edge Angle	40	70	53.3	13.2

iii) Single Bifacially Retouched Edge Tools n=110

These have unilateral, marginal, bifacial retouch on a straight to slightly convex edge. These are typically on thin flakes or pieces of shatter which are free of cortex (85), on decortication flakes (20), cortical spalls (4), and one on a bipolar split pebble fragment. Fifty-three are approximately complete, thirty-eight are edge fragments, fourteen are missing an end, and five are extensively potlidded. Raw materials include various cherts (54) of which 7 are Swan River Chert, silicified wood (20), quartzite (10), silicified siltstone (11), chalcedony (5), quartz (3), siltstone (2), obsidian (2), silicified sandstone (1), silicified limestone (1), and Knife River Flint (1).

	Minimum	Maximum	Mean	S.D.
Weight (g)	0.1	164.7	2.8	16.2
Length (mm)	15.8	106.8	60.0	44.5
Width (mm)	12.3	73.4	37.3	26.7
Thickness (mm)	1.4	27.3	4.6	3.1
Edge Angle	40	60	50.6	9.0

iv) Multiple Edge Tools n=91

This is a particularly heterogeneous assortment of tools and tool fragments. Sixty-six of these have either unifacial nibbling retouch or marginal unifacial retouch on at least two straight to convex or irregular edges. Twenty-two artifacts have two or more double bevelled edges with marginal, bifacial retouch, and three artifacts have been retouched both bilaterally and marginally bifacially to form single bevelled edges. Many of these artifacts, particularly the bifacially retouched specimens, appear to be fragments of otherwise classifiable formed tools. The blanks on which these artifacts were made are flakes or pieces of shatter having no cortex (63), cortical spalls (17), decortication flakes (6), or bipolar split pebble fragments (5). Fifty-one are approximately complete, 27 are missing an end, six are midsections, five are extensively fire damaged, and two specimens are edge portions. Raw materials represented include various cherts (49) of which seven are Swan River Chert, quartzite (12), silicified siltstone (7), silicified wood (5), silicified mudstone (3), obsidian (3), quartz (3), argillite (2), porcellanite (2), Knife River Flint (2), chalcedony (1), siltstone (1), and a single piece of an unidentified coarse grained material. It is notable that four of the silicified wood specimens exhibit marginal bifacial retouch.

	Minimum	Maximum	Mean	S.D.
Weight (g)	0.1	78.7	4.8	12.3
Length (mm)	14.2	84.8	37.1	17.5
Width (mm)	8.1	60.3	25.8	13.9
Thickness (mm)	1.9	23.6	5.5	4.0
Edge Angle	50	70	60	14.1

18) Miscellaneous Uniface Fragments n=15

These could not be classified otherwise due to their largely fragmentary condition. Seven of these are edge fragments only; the remainder are tool portions missing an end or half. Nine specimens have a single unifacially retouched edge portion, two are unifacially flaked with marginal bifacial retouch forming a single bevelled edge, and four retain two unifacially retouched edges. One of these is a cortical spall, one is a bipolar split pebble; otherwise, these are free of cortex and appear to be made on flake blanks. Raw materials include various cherts (7) one of which is Swan River Chert, silicified sandstone (4), and one each of chalcedony, Knife River Flint, quartzite, and silicified wood.

	Minimum	Maximum	Mean
Weight (g)	0.1	10.4	1.9
Length (mm)	-	16.7	16.7
Width (mm)	13.0	29.2	21.1
Thickness (mm)	1.4	12.6	6.2
Edge Angle	45	80	62.9

19) Miscellaneous Biface Fragments n=29

These are either fragments of finished tools or are fragments of artifacts broken during manufacture. Two triangular specimens, one of silicified wood and the other Swan River Chert, are largely complete but neither appears used or finished. The first apparently broke during manufacture. Nine specimens are edge fragments, 13 are bilaterally retouched retaining portions of both lateral edges, and five are probably ends of small oval to ovate bifaces. On eighteen artifacts the cortex has been completely removed; otherwise, they have a cortical surface on one face (10) including two fragments which appear to be derived from bipolar split pebbles, and one specimen was apparently a small, flattish pebble retaining a small remnant cortex surface on both faces. Raw materials include various cherts (10) of which three are Swan River Chert, silicified wood (10), chalcedony (3), silicified siltstone (3), and one each of Knife River Flint, obsidian, and quartzite.

	Minimum	Maximum	Mean
Weight (g)	0.1	4.0	1.3
Length (mm)	-	29.6	29.6
Width (mm)	-	12.2	12.2
Thickness (mm)	2.4	8.0	5.0
Edge Angle	30	65	45

20) Eccentrics (Figure 73g) n=2

These peculiar artifacts are notched flakes which are otherwise unmodified and do not appear functional. The larger example (#44866) of dendritic chert (Figure 73g), is a V-shaped ridge flake which has two parabolic unifacial notches placed on the inside edge subsequent to the detachment of this flake. The second specimen (#36733), of Knife River Flint, is a small bifacial thinning flake with a very narrow V-shaped unifacial notch on one lateral margin.

	Weight	Length	Width	Thickness
#36733	0.2	10.2	8.3	2.2
#44866	0.7	19.2	10.5	4.9

Ground Stone and Unmodified Stone Tools

1) Hammerstones (Figure 84c and d) n=2

This category is represented by two rounded quartzite pebbles, both of which have been battered on one end.

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)	Unit
29447	89.4	57.0	44.0	30.0	23-2-4
33002	35.4	35.0	29.5	24.3	26-4-2

2) Chopper (Figure 84a) n=1

This specimen is a naturally fractured cobble with an approximately conical form. The edge formed at the wide end has been battered suggesting use as a chopping tool.

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)	Unit
42713	254.9	100.0	60.0	33.7	33-3-2

3) Anvils (Figures 83a, b and 84b) n=3

Two of these are quite similar; both are long, narrow, ovoid Porcupine Hills Formation sandstone cobbles with oval cross sections. On one (#30395), use as an anvil is indicated by a localized pecked area on one flat face at the wide end, the narrow end on this artifact is broken off. On the other elongate specimen (#40446), both faces on the wide end have been pecked from use as an anvil, and further use as a hammerstone is indicated by pecking on the distal extreme. The third anvil (#43171) is a half cobble of quartzite, the cortex face of which is pitted.

Figure 81. Miscellaneous cores. Single platform cores: a, c, d; amorphous multiple platform core: b.

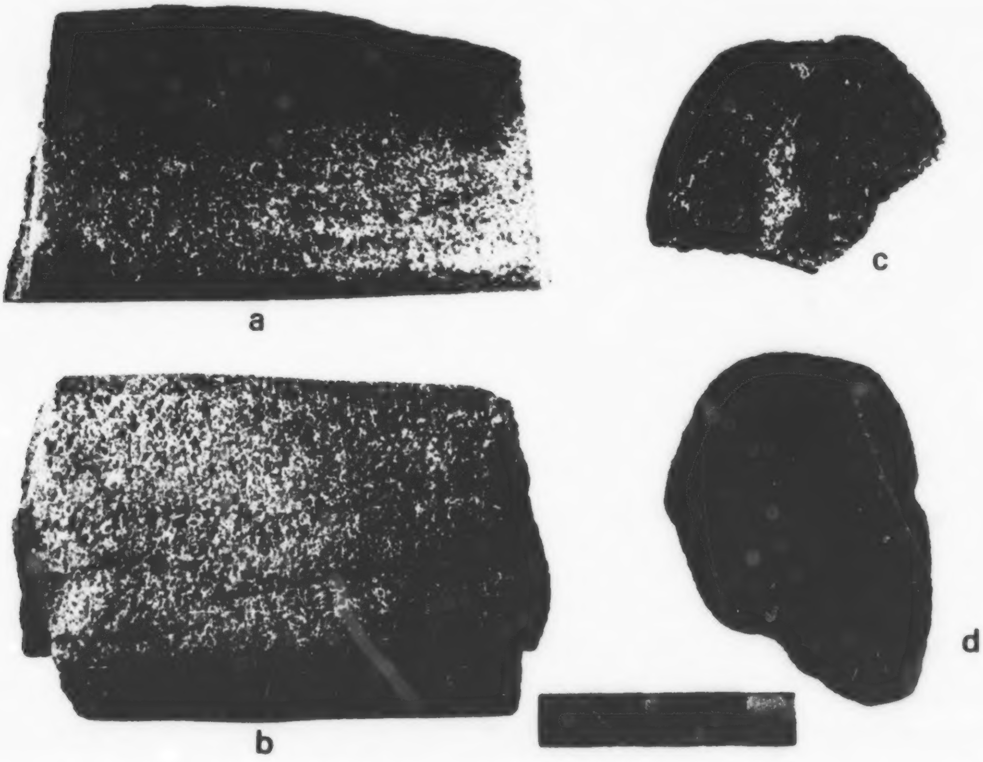

Figure 82. Ground/unmodified stone tools. Abrading stones: a, b; shaft straighteners: c, d.

Figure 83. Ground/unmodified stone tools. Anvils: a, b; grooved grinding stone: c.

Figure 84. Ground/unmodified stone tools. Chopper: a; anvil: b; hammerstones: c, d.

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)	Unit
30395	1441.5	164.0	87.0	63.5	24-3-1
40446	1376.5	212.0	77.0	59.0	31-1-4
43171	386.5	91.0	83.0	35.0	31-1-4

4) Shaft Straighteners (Figure 82c and d) n=2

Both of these are made of Porcupine Hills Formation sandstone; both are fractured ends of what appear to have been oval artifacts in planform with plano-convex cross sections. On each, a shallow linear rounded groove bisects the flat face. The overall symmetry exhibited by these artifacts suggests they were modified to achieve their present form, but weathering of this coarse grained material makes it difficult to recognize evidence of manufacture.

Cat. No.	Weight (g)	Incomplete Length (mm)	Width (mm)	Thickness (mm)	Groove Depth	Groove Width	Unit
28310	112.3	64.0	49.5	29.7	3.2	9.0	22-4-2
40341	61.2	45.0	57.0	22.2	3.0	11.0	31-1-3

5) Grooved Stone (Figure 83c) n=1

A large angular block of Porcupine Hills Formation sandstone has a linear groove, measuring 85 mm long and 14 mm wide, on a flat face. Although this groove is partly truncated at a fracture surface at one end of this rock, it is clear that the groove was contained on one face and did not extend to either edge. The groove slopes to a maximum depth of 3.5 mm at one end, and its morphology suggests it was formed by rubbing the end of a narrow implement into the flat face of this rock. A face adjacent to the grooved face is pecked, indicating alternate use as an anvil.

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)	Unit
45679	867.0	141.5	90.0	79.0	37-1 feature 2

6) Abrading Stones (Figures 82a and b) n=2

These are unmodified other than a flat face which has been smoothened. One of these (#44337) is a fragment of a weathered block or cobble of Porcupine Hills Formation sandstone with a rectangular planform, biplanar longitudinal section, and a wedge-shaped cross section. The narrow weathered face is unnaturally smoothened, presumably from use as an abrading stone. The opposite edge is blunt, possibly from use as a chopper. The other artifact is the fragmented midsection of an elongate sandstone cobble with a rectangular planform and rectangular in both longitudinal and cross sections. One face is quite smooth, probably the result of use as an abrader.

Cat. No.	Weight(g)	Length(mm)	Width(mm)	Thickness(mm)	Unit
36488	495.0	103.0	64.0	43.0	28-2-2
44337	314.2	104.0	62.0	36.5	35-2-4

Cores

A total of 277 cores were identified in the assemblage. The most prevalent core type are the bipolar cores of which 226 (81.6%) were recovered. Also represented were 37 amorphous multiple platform cores (13.4%), eight simple single platform cobble cores (2.9%), five spall cores (2.2%), and a single bifacial core (0.4%). The vast majority of these (271) were recovered from the area 2 excavations. Six cores recovered from the area 12 excavations included three bipolar cores, one simple single platform cobble core, and two amorphous multiple platform cores. One of these latter two was a particularly large (2,069 g) specimen of quartzite; otherwise, there were no characteristics which could differentiate these from area 2 specimens.

1) Bipolar Cores (Figures 77b-e and 78a-h) n=226

The relatively large number of bipolar cores recovered suggests the maximum utilization of available fine grained lithic resources. Bipolar cores in this assemblage tend to be predominantly local or regionally available fine grained microcrystalline amorphous silicates or silicified sediments. These were apparently brought to the site in the form of elongate, often flattish pebbles which were reduced in situ to provide an array of pieces suitable for various tasks, most often for expedient use requiring no further modification for cutting or scraping, and also providing flakes suitable for reduction into formed tools. The bipolar technique was most often applied in the reduction of pebbles, but was also apparently applied to any suitable piece which could not handily be reduced by other means, particularly in the case of exotic fine grained material. This might explain why 115 bipolar cores bear no cortical surface. In a few instances, small, relatively thick flakes were turned perpendicular to their long axis and impacted on their lateral margins to produce thin byproducts, and presumably exhausted, broken, or otherwise "quarried" tools also show evidence of such a mode of further reduction. This parsimonious use of fine grained, particularly exotic, material, is exemplified by the ten Knife River Flint specimens which have a mean weight of 1.6 grams, only one of which has a cortex surface. Raw materials include chert (97-42.9%), Swan River Chert (34-15.0%), chalcedony (21-9.3%), silicified siltstone (16-7.1%), Knife River Flint (10-4.4%), quartzite (10-4.4%), silicified wood (13-5.8%), silicified mudstone (7-3.1%), silicified sandstone (6-2.7%), quartz (4-1.8%), obsidian (4-1.8%), silicified limestone (3-1.3%), and porcellanite (1-0.4%). A summary of the metric attributes of these follows.

	Minimum	Maximum	Mean	S.D.
Weight (g)	0.2	38.0	3.0	3.9
Length (mm)	11.0	52.0	22.1	6.6
Width (mm)	4.0	32.0	14.5	5.3
Thickness (mm)	2.0	24.0	7.3	3.3

2) Amorphous Multiple Platform Cores (Figures 77a, 80 and 81b) n=37

Size range in this category is quite variable - fine grained materials tend to be reduced by multiple reduction modes to exhaustion, whereas coarse grained materials are less frequently so reduced, possibly because they were often desired for use as butchering tools after suitable flakes were derived. Such use of cores as choppers has been suggested by Frison at the Kobold site (Frison 1970:22). On these specimens, a platform usually is prepared by removal of a spall and using the flake facet as a platform for removing large flakes to be used as butchering tools. Raw materials include chert (12-32.4%), argillite (6-16.2%), Swan River Chert (5-13.5%), quartzite (5-13.5%), silicified wood (3-8.1%), obsidian (2-5.4%), Knife River Flint (1-2.7%), and sandstone (1-2.7%).

	Minimum	Maximum	Mean	S.D.
Weight (g)	1.1	2069.6	143.4	363.7
Length (mm)	20.0	173.0	49.4	32.5
Width (mm)	10.0	146.0	38.8	30.5
Thickness (mm)	7.0	83.0	23.7	19.1

3) Simple Single Platform Cobble Cores (Figures 81a, c and d) n=8

On these, a cortex surface was used as a platform for the removal of flakes from one face. Raw materials include quartzite (5), chert (1), silicified mudstone (1), and sandstone (1).

	Minimum	Maximum	Mean	S.D.
Weight (g)	3.3	413.6	130.0	173.1
Length (mm)	22.0	93.0	52.9	28.5
Width (mm)	17.0	73.0	43.9	23.8
Thickness (mm)	10.0	48.0	25.0	15.0

4) Spall Cores n=5

A spall removed from a cobble core was subsequently flaked either using the ventral face or the cortical dorsal surface as the platform to produce relatively short flakes. Raw materials include argillite (2), sandstone (1), siltstone (1), and an unidentified coarse grained rock (1).

	Minimum	Maximum	Mean	S.D.
Weight (g)	66.8	250.8	146.2	80.9
Length (mm)	61.0	139.0	95.0	28.1
Width (mm)	33.0	82.0	59.8	22.5
Thickness (mm)	14.0	33.0	21.8	7.7

5) Bifacial Core n=1

A solitary specimen of quartzite was flaked from either face, completely removing the cortex. The apparently random orientation of flake scars and thickness of this artifact suggest it is a core rather than a preform.

Weight	Length	Width	Thickness
213.8	78.0	68.0	37.0

Debitage

1) Introduction

Although the potential importance of debitage analysis has been recognized for a considerable period of time, there is a disproportionate amount of energy directed towards other aspects of lithic assemblages from communal bison kill sites. Site reports consistently deal with tools with an emphasis on "diagnostics", which in the northern plains are almost invariably projectile points. Exceptions to this analytical bias are the analyses of debitage from the Piney Creek and Ruby sites conducted by Frison (1967, 1968b, 1971). His analyses indicated that an examination of debitage can reveal insights into the functional applications of the tools used on the site from which they were derived, regardless of whether or not the tools themselves were represented. The rationale for this is that as actual edge-bearing remnants of tools, flakes should bear evidence of not only the nature of the artifact from which they were derived but also the manner in which those artifacts were used. As de facto refuse, or "Elements which reach archaeological context without the performance of discard activities ..." (Schiffer 1972:160), debitage should reflect the disposition of both tool reduction and tool use loci. Frison (1967, 1968b) observed five categories of retouch or sharpening flakes which could be readily identified, including biface sharpening flakes, three types of sidescraper retouch flakes, and endscraper retouch flakes. Attributes which characterized these can be briefly summarized as follows:

1. Biface sharpening flakes: These have a faceted platform, several dorsal scars, and a platform edge typically dulled from use. One problem observed by Frison was distinguishing platform edges which were dulled from use and those dulled by purposeful edge grinding.
2. Sidescraper retouch flakes: These have a single faceted platform struck from the ventral face of the tool, several dorsal scars, and scalar retouch extending onto the dorsal side from the platform edge.
3. Sidescraper rejuvenation flakes: These are struck from the ventral or "flat" face of the sidescraper using the dorsal bevel as the platform. These feature a single, relatively flat dorsal face, and a faceted platform with scalar retouch extending onto the platform from the platform edge.

4. Rejuvenated sidescraper retouch flakes: These have a flat faceted platform and a bevelled faceted dorsal face with scalar retouch extending onto the dorsal side from the platform edge.
5. Endscraper retouch flakes: These have a single faceted platform, a faceted dorsal face, and scalar retouch extends onto the dorsal face from the platform edge. Frison noted a difficulty in distinguishing these from sidescraper retouch flakes but observed that endscraper retouch flakes tended to be much smaller and were usually made of particularly fine materials.

One conclusion that seems implicit in an evaluation of Frison's results is that the value of debitage as an index of behavior is not matched by the tool component which is often highly transported, reused, and reworked, often removing items from the context of their use or manufacture. At the Ruby site, for example, Frison noted that debitage indicated use of 75 different tools, whereas only nine tools were recovered (Frison 1971:84). If anything, the analysis of formed tools discarded at a site may bias the inferred activities towards specific kinds of activities which are characterized by frequent tool discard. Other important site activities may be poorly represented and hence go undetected. This would especially be true if tool curation was extensively practiced. The results of our analysis of lithic material recovered at HSI in 1983 indicated such a bias of activities may be represented. Small formed tools, particularly projectile points, and small expedient flake tools were very well represented, whereas very few large butchering tools were recovered. This result is surprising considering the assemblage was recovered from the heart of the processing area at HSI. Furthermore, the entire lithic reduction process was better represented than we anticipated, with a particularly good representation of bipolar technology. Our expectations were partly fueled by a model of lithic resource utilization based on results obtained by Reher and Frison (1980) at the Vore site. Reher and Frison postulated that the prehistoric users of the Vore site travelled considerable distances to "gear-up" with suitable raw materials in anticipation of a season of communal bison hunting. The resulting tools made of these materials were extensively curated and reduced sparingly at the kill site. In such a scenario, there seems to be little latitude to account for the vast array of lithic materials representing all stages of lithic reduction at HSI.

An analysis of the debitage was considered necessary to address these problems. With an evaluation of the lithic reduction process represented by the debitage and an evaluation of its functional relevance, we believed we could discern patterns in lithic resource utilization which could better explain lithic material applications at HSI and also hopefully to forward insights into the assemblage formation occurring at other bison processing sites.

2) Methodology

The debitage used in the analysis was selected from the 17,129 pieces excavated from the block excavation in area 2. This debitage was scrutinized with the aid of a stereoscope, using magnifications of up to 40 diameters, and was initially sorted into two groups on the basis of the presence or absence of a striking platform. Those pieces on which a platform was not observed were not considered in this analysis. The 4,247 artifacts which were observed to retain platforms constitute the analytical sample. These artifacts will be referred to in this discussion as flakes, and as used here, are synonymous with the "platform-remnant-bearing flakes" or "PRBs" as used by Knudson (1983). For the purposes of this report, debitage other than flakes will be referred to simply as shatter.

All flakes were classified into inferred reduction stages or functional categories where possible. The five flake categories discussed by Frison above only account for flakes derived from sharpening and rejuvenating formed tools, and further flake categories were required to classify debitage resulting from tool manufacture. The relative importance of the functional flake categories to those representing flakes derived as a by-product of manufacture is dependent on site function. At the Ruby site, for example, Frison noted a marked difference in the proportion of retouch flakes to manufacturing flakes between the kill site and the processing area. At the former, flakes from retouching tools accounted for 98% of the assemblage, as opposed to 60% from the processing area (Frison 1971). At HSI, this latter figure is even less. These five categories only represented 42.5% of the flakes

(1,798) in the processing area. To account for the remainder of the flake assemblage, four additional provisional categories of flakes were discriminated based on an inferred lithic reduction sequence following models developed by Collins (1974), Katz (1976), Knudson (1983), and Schiffer (1972). These four provisional categories are: spalls, primary reduction flakes, secondary reduction flakes, and tertiary reduction flakes. The attributes which characterize these are as follows:

1. Spalls: These have a cortex platform and cortex entirely covers the dorsal face.
2. Primary reduction flakes: These include decortication and edging flakes. These have a thick, often irregular cross section and a large amount of cortex on the dorsal surface. Blank production is the inferred activity.
3. Secondary reduction flakes: These are thinner than category 2 above but often still retain small cortical surfaces and may feature humps and irregularities on the dorsal surface. The inferred production activity is the production of preforms.
4. Tertiary reduction flakes: These are flakes produced during the final stages of tool shaping and resharpening. As used here, tertiary flakes will refer to all finishing and resharpening flakes that are too small to be categorized using Frison's categories of resharpening flakes described previously.

These additional categories of flakes accounted for 57.2% (2,421 flakes) of the flakes analysed. The remaining 0.3% of the flake assemblage included 12 core rejuvenation flakes and two blades which were also categorized as technologically discrete types.

The frequency of these provisional flake categories by material type is presented in Table 13. For the purpose of this analysis and to facilitate interpretation, Frison's three sidescraper retouch and rejuvenation flake types are lumped into one category. In addition to the categorization of the flake types, three continuous variables and five nominal variables were recorded for each flake. These variables and the methodology for determining them are summarized below:

A. Raw Material: Identification was based on hardness and visual characteristics of texture, colour and diaphaneity. Wherever possible, the source was included. For the purposes of summarizing results, raw materials were grouped into categories based on shared physical qualities and location of origin. The raw material categories are grouped as follows:

1. Chert: includes all cherts and chalcedonies of unknown origin, as well as Madison Formation cherts from Montana, Etherington chert, Top of the World chert, and chert grade argillite.
2. Swan River Chert (SRC).
3. Knife River Flint (KRF).
4. Silicified Sediments: include siltstones, mudstones, sandstones, peat, and limestone.
5. Sandstone: refers to both local Porcupine Hills Formation sandstone and sandstones presumed to be derived from Oldman River gravels.
6. Porcellanite.
7. Obsidian.
8. Silicified Wood.
9. Quartzite.
10. Quartz.
11. Argillite: refers to the local siltstone grade green argillite.
12. Non-silicified sediments: local limestones, siltstones, mudstones, and shale.
13. Miscellaneous coarse grained materials: local basalt, very coarse argillite, and unidentified coarse materials.

B. Weight: measured to the nearest 0.1 g. Items weighing less than 0.05 g were recorded as having a weight of 0. The frequency of weight classes by material type is presented in Table 6.

C. Size: This was determined with the use of "size squares" where the unit of measure is the smallest square in which a flake would lie, partitioned in 5 mm increments. Size grading has been found to be a useful and expedient means of comparing large quantities of debitage in various studies (cf. Ahler and Christensen 1983). The frequency of size classes by material type is presented in Table 7.

D. Angle: This measure expresses the angle formed between the platform and the dorsal face as obtained with a contact goniometer, rounded off to the nearest five degrees. The frequency of platform angles by raw material type is presented in Table 8.

Table 6. Flake count by weight.

Weight	Chert	SRC	KRF	Obsidian	Porcellanite	Silicified Sediments	Quartzite	Argillite**	Silicified Wood	Quartz	Non-silicified Sediments	Sandstone	Misc. Coarse	TOTAL
0.0	448	109	80	40	40	115	23	2	9	2	6			874
0.1	766	135	159	24	68	214	57	21	11	7	7		1	1470
0.2	229	47	68	6	24	68	49	26	8	3	9			537
0.3	83	23	31	4	9	31	36	15	4		4		2	242
0.4	38	20	11	5	3	20	30	10		2	2	1	1	143
0.5	31	5	4	1		8	25	10					1	85
0.6	17	13	4		1	9	14	9		1	3		2	73
0.7	13	8	3		1	12	16	9			1		1	64
0.8	11	4	1			2	20	7			1		1	47
0.9	8	4	2			5	11	15	1	1			1	48
1.0	6	3		1	1	5	8	5						29
1.1	5	2	2		1	2	11	5			1		1	30
1.2	5	4				1	8	4	1	1	1	1	1	27
1.3	2	1				5	6	7		1		1	2	25
1.4	8	1			1	3	9	6				1		29
1.5	2	2			1	1	5	4		1				16
>1.5	41	25	2		1	18	200	158	2	1	20	16	18	502
Total #	1713	406	367	81	151	519	528	313	36	20	55	20	32	
Mean wt.	0.2	0.42	0.16	0.1	0.17	0.43	5.14	7.45	0.27	0.48	3.37	18.96	6.66	

Table 7. Flake count by size.

Size	Chert	SRC	KRF	Obsidian	Porcellanite	Silicified Sediments	Quartzite	Argillite	Silicified Wood	Quartz	Non-silicified Sediments	Sandstone	Misc. Coarse	TOTAL
5	256	88	37	31	19	71	19	2	3	2	4			532
10	1154	207	242	37	104	311	130	48	26	9	15		3	2286
15	215	69	75	12	23	97	135	71	3	7	14	1	8	730
20	52	26	10	1	2	26	75	53	3	2	3	3	6	262
25	16	8	2		3	5	66	44	1		7		3	155
30	4	5	1			4	36	33			3	3	5	94
35	4	1				1	19	21			2	4	2	54
40	3	1				3	16	14			2	1	1	41
45	2						6	5			2	4	1	20
50	1					1	7	8			2	1	1	21
55						1	7	4				2		14
60							4	3					2	9
65							4	3						7
70	1						2	1				1		5
75	1						1				1			3
80							1	2						3
105								1						1
Total	1709	405	367	81	151	520	528	313	36	20	55	20	32	
Mean Size	10.6	11.1	10.9	8.9	10.6	11.4	19.7	24.5	11.2	12.2	20.1	37.7	25.6	

Table 8. Flake count by platform angle.

Angle	Chert	SRC	KRF	Obsidian	Porcellanite	Silicified Sediments	Quartzite	Argillite	Silicified Wood	Quartz	Non-silicified Sediments	Sandstone	Misc. Coarse	TOTAL
20					1									1
25	2			1										3
30	7		5		1		1		1		1			16
35	17	3	5			1	4				1			31
40	28	8	13	1	5	12	8	1	2		1		1	80
45	47	9	18	5	13	15	10	5	1					123
50	80	25	37	6	21	42	41	30	4	1	2	1	1	291
55	151	41	25	7	23	60	34	31	3	1	3	2	1	382
60	243	46	61	10	17	74	75	44	6	4	8	6	6	600
65	256	49	48	7	18	66	68	58	5	2	7	2	5	591
70	310	83	67	15	16	100	106	47	3	3	12	3	3	768
75	240	55	34	12	11	66	68	35	1	4	8	2	4	540
80	190	44	29	6	19	43	61	26	6	3	7	1	7	442
85	85	24	8	4	3	19	14	11	1	1		1	3	174
90	40	11	11	7	3	13	27	16	2	1	4	2		137
95	10	6	4			5	7	7	1				1	41
100	2	1				1	2							6
>100	3	1				1		1						6
Total	1171	406	365	81	151	518	526	312	36	20	54	20	32	

E. Dorsal Cortex Cover: Coded options include:

0: no cortex on the dorsal face
1: 1 to 25% dorsal cortex
2: 26 to 50% dorsal cortex
3: 51 to 75% dorsal cortex
4: 76 to 100% dorsal cortex

Frequency of dorsal cortex is illustrated in Table 9.

F. Dorsal scars: the count of flake scars observable on the dorsal face not including those associated with platform treatment, coded as follows:

0: none - dorsal face is entirely cortex
1: one flake scar
2: two flake scars
3: three flake scars
4: four flake scars
5: five or more flake scars
6: indeterminate - flake scars are indistinct

Frequency of dorsal scar count is illustrated in Table 10.

Table 9. Flake analysis: dorsal cortex.

Dorsal Cortex	Chert	SRC	KRF	Obsidian	Porcellanite	Silicified Sediments	Quartzite	Argillite	Silicified Wood	Quartz	Non-silicified Sediments	Sandstone	Misc. Coarse	TOTAL
No Cortex	1466	352	303	66	142	420	436	248	18	19	45	12	26	3553
<25%	102	28	18	3	3	37	24	15	9		2	2	2	245
26-50%	85	13	26	7	5	34	23	12	4		1	4		214
51-75%	34	7	11	4	1	13	25	22	5	1	3		1	127
76-100%	27	6	10	1		16	21	15			4	2	3	105
Total w Cortex	248	54	65	15	9	100	93	65	18	1	10	8	6	692
% w Cortex	14.5	13.3	17.7	18.5	6.0	19.2	17.6	20.8	50.0	5.0	18.2	40.0	18.7	16.3

Table 10. Flake analysis: dorsal scars.

Dorsal Scar Count	Chert	SRC	KRF	Obsidian	Porcellanite	Silicified Sediments	Quartzite	Argillite	Silicified Wood	Quartz	Non-silicified Sediments	Sandstone	Misc. Coarse	TOTAL
None	18	4	3	1		13	14	9			3	1	2	68
One	102	22	23	7	6	42	109	104	6	6	8	3	5	443
Two	438	127	76	16	39	137	237	117	11	7	19	9	14	1247
Three	574	157	124	21	49	175	132	62	10	4	19	4	9	1340
Four	232	46	50	12	14	69	23	13	4	1	4	1	2	471
Five or More	350	50	92	24	43	84	14	8	5	2	2	2	0	676
% of flakes with more than 4 facets on the dorsal face	20.6	12.4	25.2	30.0	28.5	16.6	2.7	2.6	13.9	10.0	3.8	10.5		16.2

G. Platform Type: coded options include:

0: indeterminate
1: cortex surface
2: single flake scar
3: faceted - two or more remnant flake scars
4: other

Frequency of platform types is illustrated in Table 11.

H. Platform Edge Morphology: This refers to the condition of the edge formed by the juncture of the platform with the dorsal face. This attribute hardly exhausts the possibilities of edge morphology but the intent was to obtain an idea of the form of tool it was derived from and the stage of development of that tool, rather than to provide a detailed use wear analysis. The options for platform edge morphology used here are coded as follows:

0: indeterminate
1: sharp or unmodified
2: smooth or rounded
3: ground - modification is restricted to the edge
4: scalar retouch extends from the edge onto platform face
5: scalar retouch extends from the edge onto the dorsal face
6: scalar retouch extends onto both the platform and the dorsal face
7: scalar retouch extends onto the dorsal face accompanied by rounding

Table 11. Flake analysis: platform type.

Platform Type	Chert	SRC	KRF	Obsidian	Porcellanite	Silicified Sediments	Quartzite	Argillite	Silicified Wood	Quartz	Non-silicified Sediments	Sandstone	Misc. Coarse	TOTAL
Cortex Platform	134	20	21	3	4	35	154	256	6	3	18	16	26	696
Single Facet	765	136	111	20	65	232	192	39	19	5	25	3	5	1617
Faceted	813	250	235	58	82	252	182	18	11	12	12	1	1	1927

These characteristics are summarized in Table 12. Weight, dorsal cortex cover, dorsal scar count, platform morphology, and to a lesser extent, platform angle, have been determined as being particularly useful for pinning down reduction stages (cf. Magne and Pokotylo 1981).

3) Results

Examination of the foregoing typological system indicates that debitage can be viewed from two perspectives: technological and functional. Reference to the data on various flake attributes by material type presented in Tables 6-13 suggests that two general conclusions are warranted:

1. Reduction strategies are highly variable, and these variations correlate with different raw material types.
2. Inferred functional applications as represented by the debitage likewise vary according to material type.

Our interpretations of these data are based on assumptions of which attribute states co-vary with particular reduction stages. These assumptions and our evaluation of their significance as applied to the attributes measured are outlined below.

1. Flake weight: Weight varies inversely with technological development. Based on the data in Table 6, KRF, obsidian, porcellanite and silicified wood are primarily represented by the late stages of lithic reduction. Sandstone and coarse materials, in contrast, display little evidence of technological development. Chert, SRC, silicified sediments, quartzite, argillite, quartz and non-silicified sediments are represented by all stages of lithic reduction. By far the greatest number of flakes are very small items of fine grained materials indicating a bias toward this end of the reduction sequence.
2. Flake size: Size varies inversely with technological development. On the basis of the data presented in Table 7, obsidian, porcellanite, quartz and silicified wood are representative of the late stages of lithic reduction. Again, sandstone and coarse materials are observed to cluster at the early stages of reduction.

Table 12. Flake analysis: platform edge morphology.

Platform Edge Morphology	Chert	SRC	KRF	Obsidian	Porcellanite	Silicified Sediments	Quartzite	Argillite	Silicified Wood	Quartz	Non-silicified Sediments	Sandstone	Misc. Coarse	TOTAL
Unmodified Sharp	950	244	200	46	86	290	368	254	28	11	44	19	23	2563
Rounded	128	32	47	3	15	59	34	5	1	0	3	0	0	327
Ground	61	21	11	7	7	46	101	42	1	3	5	1	9	315
Scalar Retouch on Platform	95	25	28	4	10	17	3	5	1	4	1	0	0	193
Scalar Retouch on Dorsal	311	48	51	7	23	78	14	4	4	1	2	0	0	543
Bifacial Scalar Retouch	114	31	23	13	7	17	3	0	0	1	0	0	0	209
Dorsal Scalar Retouch and Rounding	53	3	5	0	3	12	2	0	1	0	0	0	0	79
Total	1712	404	365	80	151	519	525	310	36	20	55	20	32	

Table 13. Flake analysis: flake type.

Flake Type	Chert	SRC	KRF	Obsidian	Porcellanite	Silicified Sediments	Quartzite	Argillite	Silicified Wood	Quartz	Non-silicified Sediments	Sandstone	Misc. Coarse	TOTAL
Spall	4	1	1			2	8	10			2	1	2	31
Primary Reduction	203	37	42	5	5	84	218	262	7	5	20	18	24	930
Secondary Reduction	536	148	73	22	59	158	166	30	17	8	20	1	6	1244
Biface Thinning/ Sharpening	598	162	202	41	67	182	108	6	7	5	9			1387
Sidescraper Retouch	138	18	16	4	11	52	13	3	2	1	3			261
Endscraper Retouch	110	8	16		1	17			1					153
Tertiary Flake	119	30	17	8	8	23	13	1	2	1	1			223
Core Rejuvenation	5	2	1			2	3	1						14
Blades	1			1										2
Total	1714	406	368	81	151	520	529	313	36	20	55	20	32	

3. Flake angle: This should decrease through a bifacial reduction process and remain relatively steep with unifacial development. Considered by itself, angle is difficult to interpret. However, when combined with other attributes, it is potentially very useful. Our analysis indicates that a comparison of edge angle and flake mass can be an effective means of evaluating not only the reduction stage but also the degree to which certain aspects of an assemblage were curated. A comparison of edge angles of the different technological stage categories used here indicates a decrease in mean edge angles from approximately 90^0 for spalls to about 60^0 for bifacial reduction flakes with a concomitant decrease in weight. At the end of the reduction process, however, the distribution of edge angles tended to be the greatest and there was an actual regression to a higher mean edge angle. We tentatively attribute this result to the observation that once a biface has been reduced to an optimum thinness, any further reduction (i.e., resharpening) actually tends to thicken the cross section and, in so doing, increases the edge angle and, therefore, the dorsal angle on the subsequent flake detachments. This insight into the potential value of this phenomenon is the subject of ongoing research to be developed at length in future reports.
4. Dorsal cortex: Cortex should decrease proportional to the reduction process. This of course assumes that new materials were obtained from sources which would create a cortex on these materials (i.e., river gravels, etc.). The only raw material that was observed to lack cortex entirely was silicified sandstone which appears to be available in primary bedrock sources. Given the data presented in Table 9, quartz and porcellanite would seem to reflect the greatest extent of development, and silicified wood and sandstone the least. The lack of cortex on quartz is surprizing, as this local material was observed to be available only as small pebbles. It is possible that due to the poor fracture expressed in this material, the decortication flakes do not retain sufficient integrity to allow recognition in this analysis. Observation of attributes on quartz flakes was exceedingly difficult. The result of the high proportion of cortex on silicified wood seems to contradict earlier results. A

possible explanation is that these small flakes are derived from cortical blanks which represent marginal retouch of expedient tools. This is partly borne out by the data presented in Table 14.

5. Dorsal scar count: This is assumed to represent the complexity or level of development of the blank from which these were obtained, with an increase of dorsal flake scars initially proportional to the level of development until the flake size becomes so small that a regression in flake scar count invariably occurs. It is apparent that KRF, obsidian, and porcellanite are most likely to be extensively developed and that argillite, quartzite, and non-silicified sediments are the least likely to be extensively developed. A surprisingly low value for this attribute expressed by SRC may indicate it was not often extensively flaked but was used in earlier stages of reduction, possibly as small flake tools designed to fulfill expedient tasks.
6. Platform type: Two assumptions can be postulated: that an increase in platform scars is proportional to level of development, or that a high prevalence of single faceted platforms may be associated with unifacial reduction. This attribute is therefore difficult to

Table 14. Raw material distribution by artifact class.

Artifact Category	Chert	SRC	KRF	Obsidian	Porcellanite	Silicified Sediments	Quartzite	Argillite**	Silicified Wood	Quartz	Non-silicified Sediments	Sandstone	Misc. Coarse	TOTAL
Projectile Points	130	26	23	16	4*	32	11	9	14	2	1			268
M.U.R.L.S.***	220	37	22	14	4	54	58	17	32	7	9	1	3	478
Unifaces	28	3	6	4		5			1					47
Bifaces	14	5	2	2		3	9		10					45
Cores	131	39	11	6	1	34	21	8	16	4	2	3	1	277
Flakes	1714	406	368	81	151	520	529	313	36	20	55	20	32	4245

* includes one specimen of fused glass

** this refers to siltstone grade argillite except for projectile points which are only represented by chert grade argillite (7) and Kootenay argillite (2). Chert grade argillite is otherwise summarized as "chert", and Kootenay argillite is not otherwise represented.

*** marginally utilized or retouched lithics.

evaluate on its own merit but combined with platform edge morphology, these are useful characteristics for predicting flake type.

7. Flake type: Without replicative experiments of the entire reduction process of all these disparate raw materials, it is impossible to predict how closely these flake categories correspond to the actual reduction stages. Some interesting observations are noted, however. Most obvious is that no tool resharpening or finishing flakes were observed in the sandstone or coarse raw material categories, and only 3.5% of the argillite flakes are from the final stages of lithic reduction. This compares with 68.5% of the KRF specimens representing the final stages of tool reduction and 66.4% of the obsidian sample. All stages of lithic reduction of quartzite are well represented, although there is an apparent bias towards the initial stages of reduction. Cherts and chalcedonies dominate the flake assemblage, and 56.7% of these are representative of the final stages of reduction and rejuvenation. Tough, siliceous materials such as chert, SRC, and silicified sediments were preferred for scraping tasks, and brittle or grainy materials, such as obsidian and quartzite respectively, were not desired for use as endscrapers (of the silicified sediments, silicified siltstone was not represented in the endscraper category, either).

Our interpretations of these results suggest that obsidian, KRF, and porcellanite are represented by finishing and resharpening flakes removed from small curated tools. Flakes of chert and chalcedony, SRC, and silicified sediments represent the bulk of the flake assemblage and occur in all stages of lithic development with a bias towards the final stages. Silicified wood and quartz are represented by small items which are not extensively developed. These are assumed to represent retouching of expedient tools. The coarse grained local materials, namely quartzite, sandstone, non-silicified sediments, argillite and miscellaneous coarse items were represented only by the initial stages of tool reduction, and a flake tool industry is the inferred origin of these specimens.

Ebert (1979) has tried to demonstrate that the level of technological development, or energy expenditure plotted against a size index, is a useful approach for evaluating tool mobility, lifespan, and so on. He uses these as indices to predict four levels of artifact use and transport (Figure 85).

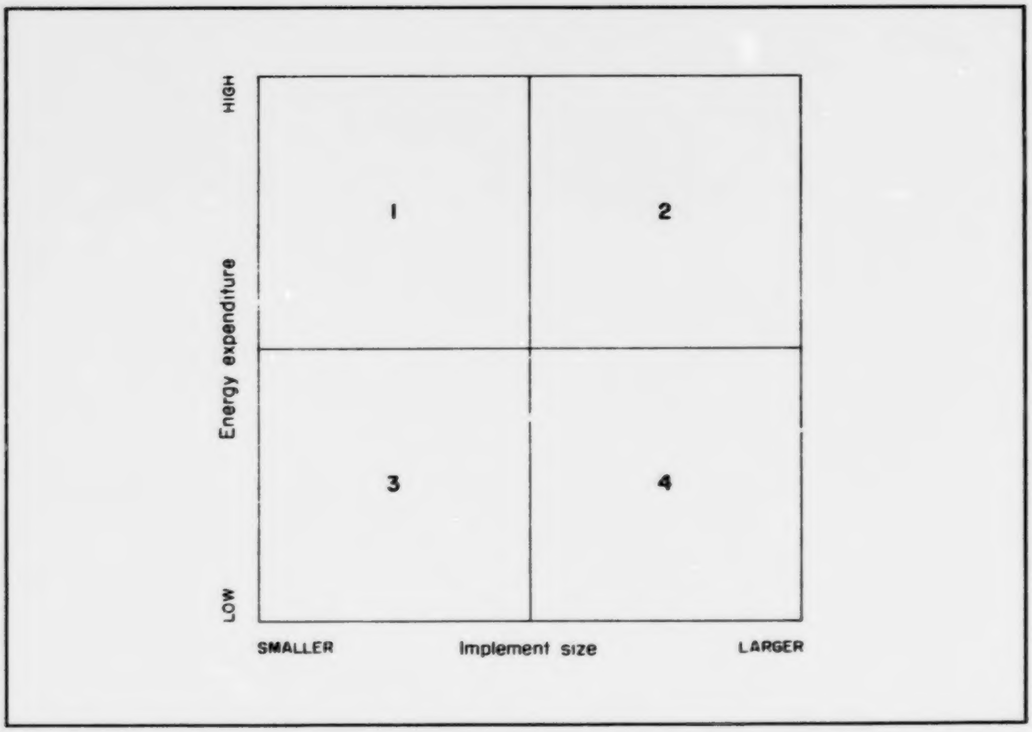

Figure 85. Four-box contingency table illustrating the relationship between theoretical linking arguments for points falling in different parts of size/energy graphs (from Ebert 1979, figure 2.2).

Box 1.	Curated, small specific-use tools, possibly pieces of a mobile tool kit. Use in jobs or tasks in which a specific set of operations is carried out.
Box 2.	Specific-use or "specific job" tools probably not transported as far as those in Box 1, but curated. These might also be tools with high symbolic content.
Box 3.	Expedient, single-use, immediately discarded tools; a situation of raw material stress may be indicated because of small size.
Box 4.	Other things, such as number of working edges, being equal, these should be tools manufactured expediently, used only once, and not transported. (Ebert 1979:68,69)

Ebert's results, when applied to the tools, are not convincing as he uses different scales to illustrate his results; however, we believe this approach can be adapted for use in debitage analysis. Flakes from HSI were plotted with the relative proportion of flakes having five or more flake scars on one axis against mean flake size for each raw material type. The results are illustrated in Figure 86. Adapting Ebert's predictions to these results indicates that flakes of obsidian,

```
                   2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
              30          * obsidian
              29
              28             * porcellanite
              27
              26
              25             * KRF
              24
              23
              22
              21             * chert
              20
              19
Dorsal        18
Complexity    17              * silicified sediments
(% of sample  16
having more   15
than four     14              * silicified wood
dorsal scars) 13
              12              * SRC
              11                                            sandstone *
              10               * quartz
               9
               8
               7
               6
               5
               4                           * non-silicified sediments
               3                 quartzite *      * argillite
               2
               1
               0                                  * misc. coarse
                  2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
                                       Mean Size (mm)
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Figure 86. Plot of dorsal complexity against size for flakes of different raw materials.

porcellanite, KRF, and, to a lesser extent, chert, are from "Curated, small, specific-use tools, possibly pieces of a mobile tool kit" (Ebert 1979:68). This is exactly the presumed origin of these exotic materials. Silicified sediments, silicified wood, SRC, and quartz would be "Expedient, single-use, immediately discarded tools; a situation of raw material stress may be indicated because of small size" (Ebert 1979:69). This again is accordant with our expectations. That is, as these are locally available in small supply or are regionally available but brought from a distance, these materials were utilized to their utmost. The remaining materials are all coarse grained and locally available. Given the distribution of these, Ebert would suggest: "these should be tools manufactured expediently, used only once, and not transported" (Ebert 1979:69). The relatively high value for dorsal complexity exhibited by the sandstone sample is a bit higher than expected, but this may be a reflection of a small sample size (20 items). Otherwise, the coarse grained materials fit Ebert's predictions.

4) Discussion and Conclusions

When all the various aspects of this lithic assemblage are considered, it is evident that the lithic assemblage at HSI represents an economical adaptation to the supply and disposition of lithic materials. In order to fully understand how lithic materials articulate into the technology of the prehistoric users of HSI, it is important to evaluate how functional requirements are compromised by such economic factors. It is our opinion that the lithic reduction process at any site is a cumulation of cultural responses to the availability of suitable materials and how they were adapted to fulfill the requisite functional considerations. The means by which lithic materials are adapted for use can therefore be expected to be tailored to the peculiarities of each site. As each site has its unique chemistry of environmental and cultural variables, generalizations regarding lithic material reduction and use to other sites outside of the research area should be tempered with these factors in mind. Two recent models of lithic reduction designed to account for assemblages recovered from bison kill sites fail to provide a contingency for varying environmental and cultural conditions. Based on results obtained from the Vore site, Reher and

Frison (1980) proposed a model which emphasized a need for "gearing up" in anticipation of communal hunts. The resulting highly curated tool kit of materials, often derived from very distant sources, would be manifest in an archaeological context as small broken formed tools and tool maintenance debris. The "gearing up" model further proposes that the advanced planning of the large communal kill events will result in a general paucity of lithic remains associated with the early stages of tool manufacture and reduction, as these tasks will have largely been completed prior to the hunting episode.

Bamforth (1985) offers a different scenario to predict the lithic assemblage composition at small non-communal kill sites. His results, based on a refitting and use wear study at a non-communal bison kill site, suggest that these sites, as representative of unplanned events, would feature tool kits which are a response to situational needs and would consist largely of expedient tools. He suggests that communal kill sites emphasize an anticipatory technology and, conversely, that single or isolated kills are characterized by a situational technology.

On the contrary, evidence from HSI reinforces our belief that an assemblage at any site, whether a mass communal kill or an isolated kill, reflects a situational response to available lithic materials. Proportions of tools indicating an anticipatory curated tool kit as opposed to a situational expedient component vary according to cultural and geographical factors. Similar observations were made by Binford (1978) in his discussion of personal gear, situational gear, and site furniture. A bias of one component of the assemblage over the other may merely be a reflection of the supply of raw materials at hand. Where plenty of suitable raw materials are available, one would expect few exotic materials; conversely, where lithics are in poor supply, exotic materials would be better represented. It may be that when no suitable lithics were available to satisfy situational needs, substitutes would be used. Such a hypothesis might help to explain the large number of bone tools used for butchering tasks at some sites and the relative scarcity of these at others such as HSI. Given the consistent patterns of the application of disparate raw materials at HSI, we have developed an inferred model of the lithic reduction sequence at HSI which satisfies considerations of both anticipatory and situational needs. Despite the absence of stratigraphy and hence temporal control, we believe that this consistent treatment of various raw materials indicates patterns of lithic use and reduction strategies of some temporal continuity. The following is an elaboration of this model based on results obtained both in 1983 and 1984.

The lithic materials used at HSI can be described as reflecting a broad range of lithologies with varying degrees of hardness, brittleness, and texture. It can generally be stated that coarse grained materials with poor conchoidal fracture were readily available in the immediate vicinity of HSI, but fine grained materials with good conchoidal fracture were in short supply and were largely brought from a further distance. The lithic suite employed at HSI is not only of diverse lithology but also of diverse availability. Operationally, the availability of discrete materials can be summarized as originating from a triad of catchment realms: local, remote, and exotic.

Local materials, those found in the vicinity of HSI either at the site itself or in the nearby Oldman River gravels, include Porcupine Hills Formation sandstone, argillite, quartzite, limestone, coarse basalt, quartz, chert, and possibly silicified wood. Porcupine Hills Formation sandstone, the bedrock which outcrops at HSI, is virtually useless for knapping, but it does provide a suitable medium for ground stone tools. Argillite and quartzite were the favorite materials for heavy or large expedient flake or core tools, with the occasional especially fine grained piece modified into formed tools (Table 4). The argillite is of particularly variable quality, ranging from a coarse argillaceous sandstone to a very fine grained almost "chert-like" material.

The reduction process of local materials was geared to the production of large flake tools for butchering tasks. Large wedge shaped flakes were especially suitable for chopping tools. When struck from cobble cores using a cortex platform, these tend to have a naturally backed end. Cores of local material tend to be large single platform cobble cores. Thin flakes struck from these were used as cutting tools, and were usually discarded without rejuvenation. The resultant cores would also be serviceable as chopping tools.

Neither limestone nor basalt seemed to be popular for any application of lithic materials, whether for ground stone, flaked stone, or even boiling stones. Quartz and silicified wood are available in small quantities, but both have poor conchoidal fracture - the former is riddled with internal fractures, the latter has a tendency to break along flat structure faults. Both quartz and silicified wood occur in the tool assemblage as small expedient tools usually with one utilized or marginally modified edge, although particularly homogeneous pieces of silicified wood are more extensively developed. Although chert is numerically the best represented raw material at HSI, cherts derived in the vicinity of the site do not appear to provide an important contribution to the assemblage; the rare pebble cherts that were observed in the Oldman gravels were characterized by uncontrollable blocky fracture.

Local materials represent a convenient source which can be exploited spontaneously. The inferred procurement mode for these materials is simple foraging. Due to the close proximity of these materials to the site, the predicted occurrence of these in an archaeological context would be manifest in all stages of lithic reduction. There may be less of a tendency to exercise tool maintenance when these materials are readily available; hence, reuse of these items may be relatively poorly expressed.

Remote or regionally available materials are those which do not occur in the vicinity of HSI but are available in the territory, presumably exploited during the seasonal subsistence round. Barring a radical development in psychic archaeology, it would be difficult to precisely delineate such a territory of exploitation. Raw materials presumed to be derived from remote sources include various cherts, chalcedonies, a variety of silicified sediments, and probably small amounts of good quality quartzite, silicified wood, and basalt when the opportunity permitted. The single most prevalent type of chert represented in the lithic assemblage at HSI is Swan River Chert which has not been observed to be available anywhere near HSI. Despite being an important raw material well represented in assemblages from east-central Alberta, Saskatchewan, and west-central Manitoba (Campling 1980), the origin of this material is uncertain. It is apparently available as large cobbles in till in eastern Saskatchewan and western Manitoba (Campling 1980), although the volume of this material at HSI suggests a nearer source, likely in till in southeastern Alberta, as Gryba has suggested (1983:46). Gryba's suggestion that it may also derive from the Blairmore pebble conglomerate is unlikely, although this latter source undoubtedly supplied some pebble cherts and silicified sediments. The origin of much of the chalcedony is probably Montana or the Rockies, but some of the pale beige to white chalcedony appears to be similar to the plate chalcedony which occurs as thin lenses in many regions of southeastern Alberta. The Rocky Mountains and foothills are believed to be the origin of most of the silicified sediments including silicified mudstone, limestone, siltstone, and sandstone. With the exception of the latter which appears to be derived from bedrock slabs, these materials occur principally as pebbles. Chert quarries in the Rockies such as the Etherington quarries in the Livingstone Range were certainly exploited. Whether or not cherts from more distant sources, notably the highly variable, good quality Madison Formation cherts from various quarries in Montana and Top-of-the-World Chert from British Columbia, represent material from visited localities or were objects of trade is a moot point.

Binford has observed that the Nunamiut are familiar with an enormous territory (Binford 1979), the implication being that not only are hunter gatherers capable of covering considerable distances, but that it is a normal consequence of their lifestyle. In this light, raw materials from remote sources are not obtained as the result of a direct lithic procurement strategy but are probably "normally obtained incidentally to the execution of basic subsistence tasks" (Binford 1979:259). Remote materials are often opportunistically accumulated, and the degree to which they were curated may have been dependent on an intimate knowledge of the lithic resources in the areas of future visitation. Rocks are heavy, and retention of material for transport would obviously necessitate economizing on this bulk. The easiest way to reduce weight is to convey finished tools or tool blanks; however, this leaves little contingency for flexibility. At HSI, there is no present evidence that suggests that some form of generalized blank was being brought to the site for further reduction, such as Huckell (1978) proposed for the

Hudson-Meng assemblage, although this would be hard to detect without a major refitting analysis.

The large number of bipolar cores represented in the assemblage demonstrably originating from remote sources indicates a need was recognized for fine grained materials at HSI to satisfy numerous functional requirements that could not be met with local materials. Apparently, pebbles were recognized as a convenient form to transport this material. Pebbles could be reduced on site to provide an array of byproducts primarily for expedient use and also to provide flakes for modification into small formed tools to replace curated items exhausted at the site. It does not seem likely that the primary functional context of pebble cores could be the production of blanks for formed tools, as the material would probably have to be tested first.

From this perspective, remote materials are represented in all stages of lithic reduction, with a bias towards smaller items and the final stages of lithic reduction. Tools of these materials tend to be exhausted or broken, and any sizeable byproducts usually bear indications of use or marginal modification. Every effort was made to use all fine grained materials to the point of exhaustion. Fine grained materials were resharpened and rejuvenated to the extent that broken, worn out formed tools were occasionally used as cores for production of small flakes for expedient tasks.

Exotic materials are those which are not available in the territory exploited and must have been obtained by trade. Any suggestions as to which raw materials are exotic may be more inferential than real, as it is doubtful that the exotic/remote frontier could ever be reconstructed. The position of this frontier may be quite transient; the area within the range of exploitation of one generation, for example, might not be available to the next.

We assume that Knife River Flint is an exotic and that Yellowstone obsidian, porcellanite, Madison Formation cherts, Top-of-the-World Chert, and Kootenay Argillite were normally obtained through trade. Given the wide ranging territory exploited by the prehistoric inhabitants of the plains, distance alone cannot be used as an argument for trade. Reeves, for example, has suggested that the peculiar morphology of diagnostic artifacts of Kootenay Argillite actually represents the participation of

"... visitors from Kootenay Lake ..." at HSI during the Pelican Lake occupation, although this source is 800 km to the west (Reeves 1983b:124H). In a similar vein, despite the presence of raw materials from widespread distant sources at the Vore site, Reher and Frison suggest that those raw materials were directly acquired by the users of the Vore site and that they "do not consider trade of cherts, quartzites and other material to be a significant factor on the Plains" (Reher and Frison 1980:121). At HSI, exotic materials were represented almost exclusively by small, usually broken, tools and a considerable number of small, thin, detrital byproducts of tool maintenance. Although well represented and used to exhaustion, the occurrence of exotic materials at HSI may not necessarily be functionally important. Exotic materials such as obsidian or Knife River Flint may demonstrate superior flaking qualities, but other materials from nearer sources can often provide functionally suitable qualities. Although obsidian is relatively easy to flake and can possess a keen edge unsurpassed by other materials, its brittleness and sharpness render it unsuitable for many applications which can be better executed with a tougher material such as chert. In some cases, it would seem that the extrinsic value of an exotic supercedes its functional utility. It may simply be a case of status conferred to someone possessing a material readily identifiable as exotic, or it may represent idiosyncratic dogma ingrained in the belief system. Gould et al. (1971) observed of the aborigines of Western Australia a preference for particular lithic sources for non-functional reasons:

> These preferences have little to do with the actual working qualities of the different materials, for, in fact, these are all satisfactory materials for stone chipping. Rather, these preferences appear to be a reflection of the close totemic ties each man has to the particular region in which he was born and from which he claims totemic descent. Thus a man may have a sense of kinship with some of these localities, and he will value the stone material from them as part of his own being. Stone materials thus acquired are not sacred in any strict sense but are nevertheless valued highly enough to be transported over long distances by the owners (Gould et al. 1971:162).

Acquisition of exotics as defined here necessarily occurs by trade, but this is not meant to imply a formalized trade with concomitant interpretations of social organization and trade networks. Trade may occur as simple gift exchange during intergroup contact where the actual trade of goods is incidental to the potentially more important functions served by social interplay. Trade may merely serve as a convenient mechanism for such contact.

Whether exotics enter the site as the objects of trade or the tokens of contact, their discard on a site effectively incorporates these materials into the local catchment universe where opportunities exist for future reuse or reworking. Caution should be exercised, therefore, in any interpretation of trade based on the recovery of artifacts made of exotic materials in a multicomponent site. Given the apparent frugality of the prehistoric users of HSI with fine grained materials particularly, if the situation demanded it would seem likely that any usable piece of lithic material would be pressed into service.

In summary, the lithic assemblage at HSI represents a heterogeneous assortment of raw materials developed and utilized in particular ways. It was necessary to examine both the tools and the debitage categories to evaluate how these materials became incorporated into the lithic assemblage. The lithic assemblage at HSI can be viewed as an efficient, flexible adaptation to the supply of lithic materials and the means by which these materials were employed to fulfill the functional requirements necessitated by both bison kill and processing activities.

Faunal Remains

Introduction

The 1984 faunal report represents an analysis of the animal remains from the second year of excavations in the processing area at HSI. Our previous field season (1983) was devoted to the exploration of the processing area and assessment of the impact of constructing an interpretive complex on the site. To achieve these goals, a sampling method was used which required widespread placement of test units throughout the site. The faunal report was limited, therefore, to a general summary of relative quantities of species, a taphonomic assessment of the material excavated and a comparison of the bison remains recovered to a simplified model of expected bison remains in a processing area (Brink et al. 1985:160).

The 1984 analysis is a more focussed attempt to unravel bison butchering and processing practices at HSI. Two spatially separate excavations form the basis of this report. The largest, a block excavation peripheral to the main processing area, allows an examination of trends in butchering techniques at HSI over the past 3000 years (see Figure 2). A second group of excavation units, 500 m to the south of the main processing area, represents a much less intensely used area of the site (see Figures 2 and 4). This second area may yield evidence of a different form of bison hunting and processing than would be expected at a bison jump.

This section is divided into eight subsections: 1) Excavation Techniques; 2) Laboratory Techniques; 3) Faunal Assemblage; 4) Taphonomy; 5) Bison; 6) Intra-site Selection and Processing; 7) Area 12 Faunal Remains; 8) Other Species.

Excavation Techniques

As much of the data necessary for analysing the butchering processes would be derived from the faunal material, a directed effort was made to increase the amount and accuracy of the faunal data. We have discussed elsewhere in this report, and in previous reports (Brink et. al. 1984, 1985), the generally poor quality of bone preservation from the processing area. In 1984, we made an effort to counteract some of the limitations imposed by the poor faunal preservation by enacting measures designed to augment the recovered and analysable data base.

Three methods were used to preserve "ephemeral" information and minimize time spent on gathering data which would be of limited value. All crew members were given a primer in bison skeletal identification. Familiarization with bison was deemed necessary because identification of elements and recognition of spatial patterning of elements was often only possible at the time of excavation. In addition, a faunal analyst was on site to aid in fragment and non-bison element identification. This emphasis on identification of elements at the time of excavation aided dramatically in increasing our ratio of identifiable bone as compared with the 1983 excavations.

Crew members were asked to fill out coded faunal level forms to record spatial relationships. Identified bones were bagged by 50 cm^2

subquadrant and 10 cm level unless they showed some unusual quality such as bone concentrations, foetal material or formed part of a feature. Any such special materials were bagged separately and labelled with the appropriate provenience information. Small scraps of unidentifiable bison bone were recycled into the unit backfill and these were mixed and sampled. The rational, methodology and results of this sampling of non-identifiable bone scraps are presented at the conclusion of this section.

Laboratory Techniques

The identification of the faunal material was completed in a trailer laboratory on site. Comparative material included a six year old male bison (Bison bison), a mature female wolf (Canis lupus), a mature male ground squirrel (Spermophilus richardsonii) and a mature male northern pocket gopher (Thomomys talpoides).

The cataloguing of faunal remains involved the identification of species, element (or element portion), side, approximate age (i.e., foetal, juvenile, mature) and noteworthy alterations (i.e., cut marks, burning). The assignment of element portions was completed with the aid of a coding system which was specifically developed for Head-Smashed-In. This system employs logical breakdowns of each element into sections which are useful for summarizing the faunal assemblage. As this coding system is basically descriptive, it does not attempt to address breakage patterns associated with taphonomic or butchering processes (cf. Brumley 1980).

The 1984 faunal coding system differed considerably from that employed in 1983. In the latter year, we employed the identification and coding manual compiled by Brumley (1980). This manual seeks to identify meaningful butchering or breakage units of bison bone based on Brumley's experience with plains bison kill sites. We found this manual to be too detailed for our needs which basically sought to catalogue recovered bone portions rather than to impose the presumed analytical framework of Brumley's manual on the HSI fauna. The code we devised is a simplified version of Brumley's for we reduced considerably the number of portions an element could be identified as. For example, a femur was coded as either complete, proximal end, distal end or midshaft. For the same bone, Brumley offers 15 different element portions. The full list of element and element portions contained in our revised manual is presented in Table 15.

Our decision as to which element portions would be recognized in our manual was in part an attempt to compromise between the complexity of Brumley's manual and still retain some potentially useful breakdowns of bone elements. The latter goal forces a recognition of precisely how and why the coded faunal material is to be subsequently examined and discussed. In the case of long range research at HSI, we have identified several potential problem areas in faunal research as ones which we intend to pursue. Two of these involve the application and assessment of models of large mammal carcass butchering and utilization proposed by Binford (1978) and Speth (1983). The arguments and analyses of these authors focus, respectively, on the concept of "utility" in human utilization of carcasses, and on the importance of sex and seasonality in influencing butchering at kill sites. More will be said later in this section about these topics; for the present, the important point is that prior knowledge of an intent to juxtapose HSI faunal material with the arguments raised by these authors in part determined our faunal identification system. The manual used in 1984 allows direct comparison of our data with data and analyses contained in the works of Binford and Speth. Such comparisons were not possible with the manual used in 1983.

All bison material which could not be identified to element was returned to the appropriate backdirt for later sampling. The exceptions to this method were feature material and non-bison remains. All feature material was kept, and all non-bison remains were saved for subsequent identification.

Information was recorded by numerical code on computer data sheets. Each identified specimen record contained a catalogue number, provenience data, biological nomenclature, element, portion of element, associations, alterations, age category, number of fragments, and weight.

An effort was made to ensure that each record represented one specimen regardless of the number of fragments it contained. Refitting or the potential for refit were used as criteria for including a number of pieces as one specimen. Refitting was originally attempted using material from one subquad and level. Once this task was completed, an

Table 15. Head-Smashed-In faunal element code values.

SECTION CODE* Element	HSI CODE Element Portion	SECTION CODE* Element	HSI CODE Element Portion	SECTION CODE* Element	HSI CODE Element Portion	SECTION CODE* Element	HSI CODE Element Portion
3 Skull	1-Complete 2-Calvania 3-Nasal 4-Maxilla 5-Basio-occipital 6-Eye orbit 7-Petrous 8-Tooth row 9-Horn core	11 Sacrum	1-Complete 2-Centrum 3-Wings 4-Body	20 Scaphoid	N/A	37 Metacarpal	1-Complete 2-Proximal 3-Distal 4-Midsnaft
4 Mandible	1-Complete 2-Coronoid 3-Proximal 4-Midsection 5-Distal	12 Caudal	1-Complete 2-Centrum 3-Vertebral Projections & Neural Arch	21 Lunate	N/A	38 Metatarsal	1-Complete 2-Proximal 3-Distal 4-Midshaft
5 Hyoid	1-Complete 2-Great Cornu 3-Shaft	13 Ribs	1-Complete 2-Head 3-Body 4-Costal Cartilage	22 Cuneiform	N/A	39 Metapodial	1-Complete 2-Proximal 3-Distal 4-Midsnaft
6 Atlas	1-Complete 2-Body 3-Wings	14 Sternabra	N/A	23 Pisiform	N/A	40 First Phalanx	N/A
7 Axis	1-Complete 2-Centrum 3-Vertebral Projections	15 Pelvis	1-Complete 2-Ilium 3-Acetabrilum 4-Pubis 5-Ischium	24 Magnum	N/A	41 Second Phalanx	N/A
8 Cervical Vert	1-Complete 2-Centrum 3-Vertebral Projections & Neural Arch	16 Scapula	1-Complete 2-Lateral end (Glenoid) 3-Crest 4-Anterior border 5-Blade	25 Unciform	N/A	42 Third Phalanx	N/A
9 Thoracic Vert	1-Complete 2-Centrum 3-Vertebral Projections & Neural Arch	17 Humerus	1-Complete 3-Proximal 3-Distal 4-Midshaft	26 Fifth Metacarpal	N/A	43 Proximal Sesamoid	N/A
10 Lumbar Vert	1-Complete 2-Centrum 3-Vertebral Projections & Neural Arch	18 Radius	1-Complete 2-Proximal 3-Distal 4-Midshaft	27 Femur	1-Complete 2-Proximal 3-Distal 4-Midshaft	44 Distal Sesamoid	N/A
		19 Ulna	1-Complete 2-Proximal 3-Distal 4-Midsnaft	28 Patella	N/A		
				29 Tibia	1-Complete 2-Proximal 3-Distal 4-Midshaft		
				30 Lateral Malleolus	N/A		
				31 Astragalus	N/A		
				32 Calcaneus	N/A		
				33 Navicular Cuboid	N/A		
				34 Cuneiform Pes	N/A		
				35 First Tarsal	N/A		
				36 Second Tarsal	N/A		

*from Brumley 1980

effort was made to combine the individual specimens from within and between units. In the case of the large block excavation, the two arbitrary levels were also recombined as no distinguishing stratigraphy was found.

Problems of identification were eased considerably by having a faunal analyst on site. Many identifications were made in situ, before the bone crumbled. These specimens were wrapped in foil, and labelled so identification was assured in the laboratory even when the material had been reduced to fragments.

Difficulties still plague those who attempt to identify material from processing areas, however. The shafts of long bones reduced to small fragments through cultural or taphonomic breakage are very hard to assign to a specific element. As a result, some specimens may be under represented in comparison to other, more unique long bone fragments. For example, the tibia shaft retains a number of characteristic marks which often permit identification. Other long bone shafts are often more problematic. As a result, we can expect a bias in favour of tibia shaft fragments in our final catalogue.

Faunal Assemblage

Intensive archaeological attention has been given to bison procurement sites in the last 15 years, but the vast majority of this effort has been centred on the kill and initial butchering areas of these sites. The HSI project is a three year investigation focussed primarily on the camp/processing portion of a bison jump. The project, now in its second year, represents a sustained investigation of the processes of rendering the raw bulk of a communal kill to storable, preserved food supplies.

The processing region of HSI is a very large area where the archaeological record has been complicated by multiple occupations which are not delineated by any form of stratigraphy. Wind deflation of soils has contributed to the formation of a cultural layer of material from the surface to 15-20 cm below the surface which contains at least 3000 years of prehistoric material.

The 1984 research design called for exploration of the northern periphery of the processing area. It was hoped that excavation away from the centre of activity (the "core" area) would simplify archaeological reconstruction. This indeed proved true. A large block excavation, 7x8 m, did reveal evidence of multiple occupations but to a much reduced extent than witnessed by our 1983 excavations in the "core" area (Brink et al. 1985). Analysis of this excavation is mainly statistical in nature in an endeavour to uncover trends in butchering practices which extend throughout this 3000 year period. This search for trends, or recurrent patterns, in faunal processing is necessitated by the general inability (with a few exceptions, such as some features) to distinguish between discrete cultural and temporal bison processing events at the site.

A second concentration of four 2x2 m units in area 12 (as discussed in Chapter 2) resulted from mitigation excavations designed to assess the impact of a proposed parking lot for the interpretive centre. Two of these units were placed over a drainage channel and yielded rich stratified faunal remains in their lower levels (c. 50-90 cm B.S.). Analysis of these units is more descriptive because these faunal remains seem to represent more or less unique events.

The heart of the following analysis lies in bison processing. Two aspects are investigated: 1) preferential selection; and, 2) the processing methods. Preferential selection refers to a butchering preference for animals belonging to certain age/sex classes and for a preference of certain parts of the animal for different types of processing. Processing methods in this context mean the techniques used to produce different skeletal byproducts.

Taphonomy

The nature of destructive taphonomic processes as they affected the faunal assemblage at HSI has been detailed in the 1983 site report (Brink et al. 1985). The presumed major causes of non-cultural breakdown of bone at HSI are: 1) prolonged exposure of the bone on the site surface due to a lack of soil deposition; 2) trampling by large mammals and prehistoric hunters during reuse of the site; 3) the adverse effects of the environment on the exposed bone, especially the hot, dry, windy summers and the consequent dessication of the bone.

Bones excavated in the 1984 field season seemed in slightly better condition than their 1983 counterparts, but this remains a subjective impression. If true, it is probably a reflection of the fact that, as mentioned previously, we believe this northern periphery of the processing area, where our block excavation was located, was the scene of less intensive use by the prehistoric site inhabitants. Bone which lies on or close to the surface is in poor condition. Faunal remains in the deeper features survive in good to excellent condition.

Surficial bone was in relatively good condition in the case of small, dense elements. Large fragile elements tended to fracture in parallel, longitudinal cracks and/or flake apart. This destructive process was not, however, always consistent across the large block excavation. Occasionally, extremely fragile elements such as foetal material and costal cartilage would survive intact.

No evidence of large carnivore scavenging could be discerned, but we believe that this type of disturbance and destruction occurred frequently. The absence of evidence for carnivore modification of the HSI fauna is believed to be a result of the poor condition of the bone. Bone surfaces are dessicated, split and friable and hold little potential for isolating the gnaw and puncture marks of large carnivores. Many of the bones did display gnaw marks from small rodents but their destructive impact upon the assemblage as a whole is probably mild.

Bison

Bison comprise 98.5% of the faunal assemblage as calculated by the total number of identified skeletal fragments (NISP) (Table 16). All bison were classified as *Bison bison*, the extant species. This assumption was possible because of the existence of temporally diagnostic projectile point types found in association with the faunal assemblage. The earliest point type, Pelican Lake, delineated a lower temporal boundary of 3000 years B.P. (Reeves 1983b:135), well within the period of predominance of *Bison bison*.

No subspecific assignment was made of the material. Head-Smashed-In is located in an ecotone which is transitional between the habitats of wood and plains bison. The immediate environment is short grass prairie, the domain of the plains bison (*Bison bison bison*). The gathering basin

Table 16. Master list of species (by NISP).

	AREA 2	AREA 12	TOTAL
Bison bison (Bison)	3370	2105	5475 (98.5%)
Odocoileus hemionus (Mule deer)	3	0	3 (.1%)
Castor canadensis (Beaver)	1	0	1 (.0%)
Thomomys talpoides (Northern pocket gopher)	2	1	3 (.1%)
Spermophilus richardsonii (Richardson's ground squirrel)	1	0	1 (.0%)
Canis lupus (Wolf)	7	1	8 (.1%)
Canis familiaris (Dog)	49	9	58 (1.0%)
Canis latrans (Coyote)	1	9	10 (.2%)
Lepus sp. (Rabbit/Hare)	1	0	1 (.0%)
TOTAL	3435 (61.8%)	2125 (38.2%)	5560 (100.0%)

merges with the Porcupine Hills, an environment presently suiting the wood bison (*Bison bison athabascae*). If the vegetation of the Porcupine Hills has remained stable for the past two or three millenia, a point of some debate, it is possible that both subspecies are represented in the faunal assemblage.

Two sets of excavations yielded the bison sample present in the faunal assemblage. The first is the large block excavation (56 m^2) near the periphery of the main processing area. A second cluster of four 2x2 m units, 200 m southwest of the southern extent of the core processing area, is contrasted in being deep, stratified and producing a rich faunal stratum from 50-90 cm below surface.

The block excavation (area 2) was analysed for evidence of selection preferences in animals and portions of animals. This information is detailed below. The southern excavation (area 12) has not been similarly analysed at this time, but summary descriptions and statistics follow the processing area analysis.

Intra-site Selection and Processing

Archaeological investigations and, therefore faunal analyses, of bison procurement sites have traditionally centred on the kill area. It is the kill area which presents the archaeologist with the type of information which helps outline the cultural history of a region. Kill areas are often stratified and rich in temporally diagnostic projectile points. Faunal remains in this area of a site are often well preserved and plentiful. Analysis of these remains is directed towards the evaluation of primary butchering practices which may entail how the animal was cut up into transportable portions. Seasonality of the site can often be estimated from tooth eruption and wear rates, and the ratio of the herd population can be ascertained from the many complete bones excavated. Butchering tools, made from portions of the bison carcass, may also be identified (cf. Reher and Frison 1980).

Excavation of a processing area can be contrasted on almost every point with the investigation of a kill deposit. Whereas a kill site must meet fairly strict topographic criteria to ensure success, a suitable processing area requires only roughly flat land that is preferably upwind from the bison carcasses, and perhaps a supply of water. As a consequence, faunal remains in the kill and processing areas of a site are often subjected to vastly different environmental pressures. The unprocessed or undesirable portions of the carcasses are left under the cliff where they may be scavenged and/or are eventually covered by slope wash, loess deposition and topple. Carcasses transported to the processing area may be exposed to the direct effects of sun, wind, rain and snow for many years before they are buried. In addition, some of the bone may have undergone intensive cultural reduction by way of marrow extraction and degreasing processes, leaving few of the bone specimens intact. Studies such as seasonality, which require intact maxillary or mandibular tooth rows, are obviated unless a sufficient sample size is obtained.

There are many variables which determine how a herd of bison carcasses is butchered. This multitude of variables would likely include all of the following: the needs of the people at the time of the hunt, the distance from the kill site to the camp or processing area, the number of people present to do work, number of animals killed during the hunt and the condition of the animals killed. The resulting interplay of these major considerations determines the extent and the method in which the bison carcass is utilized, as illustrated in the following quotation:

> The Plains Indians apparently lived according to a feast or famine economy (Ewers 1955:168-170). When buffalo meat was plentiful the Indians often ate only the choice parts of the animals, but, when the food supply was dire, the Indians utilized every part of the buffalo from which any amount of nourishment could be obtained.
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> After a successful hunt the Indians usually preserved some meat for times when fresh meat was scarce, which occurred most often during the winter months. But they did frequently find themselves on the brink of starvation, and at such times they used all of the edible parts of any buffalo they were able to kill. The American trader Henry Boller observed of the Indians of the Upper Missouri River area, "When there is plenty of meat, the large bones and coarse pieces are always thrown aside, but in times of scarcity there is absolutely nothing left but the Head" (1959:233-234) (Verbicky-Todd 1984:182-183).

The terms "light butchering" and "heavy butchering" were used by Wissler (1910) to differentiate the types of carcass reduction employed when distance was a factor. Heavy butchering is described as follows:

> In dressing, the skin was cut down the median line of the breast and worked loose. Then the carcass as it lay on the outstretched skin was disembowled. The manner of its dismemberment depended on the distance from camp. Assuming that the carcass was in camp, the procedure for buffalo or deer was about as follows:--The fore quarters were removed by cutting down through the shoulder joints. The cuts were made at the shins. The hind legs were cut off and the quarters cut at the hip joints. The back-fat was removed in broad bands. The breast and belly were cut away in one piece; then the short ribs, eight on a side, in two pieces; also two similar pieces of neck ribs. The parts of the loin containing the kidneys were taken next. The "boss ribs" (hump) were stripped. If there was a feotus it was tied up with the "boss ribs". The back bone was cut into two pieces. A chunk of meat from the rump and one from the neck were taken. The heart, tongue, brain, paunch and small intestines were taken. Sometimes the hoofs and some of the head meat were also taken (Wissler 1910:41).

An example of "light butchering" is outlined by the same author:

> "Light butchering" was the term applied to a method much used when the killing was far away from camp or when several animals were to be transported by one or two horses. In this case, the loins were cut out of the quarters. Then these were tied in pairs as before. The back-fat was removed in two pieces, and

> tied so as to lay across the horse. The loins with the kidneys, the meat from the boss ribs, the heart, the tongue, breast and groin were taken as before. The flesh over the ribs was worked off in one piece. The paunch was emptied and the small intestines stripped. The whole was then packed in the skin on a horse as for the "heavy butchering." Thus, the bones were left behind (Wissler 1910:42).

Butchering techniques, as they apply to bison jumps, portray only a limited number of the repetoire of pragmatic methods which the plains peoples used to reduce a bison carcass to usable portions. Because the distance from the kill locale to the processing area is often short and the number of animals driven over the cliff usually large, many of the butchering techniques needed to cope with long distances and small kills are inappropriate to a communal bison jump.

If the peoples were experiencing a particularly prosperous period, butchering may consist of removing only the delicacies, such as the tongue, leaving much of the remaining carcass untouched. Hunts of such a nature would leave little or no evidence of the event in the processing area. In the other extreme, needy people preparing for a long winter would utilize every portion of preferred carcasses. Evidence of these processing activities would be amply represented in a processing area.

The process of deciding upon which portions of the bison carcass will be butchered and utilized represents a complex series of decisions, but for our purposes, these can be reduced to two levels. The first decision level at the kill site involves the determination of which portions of the animal carcasses to leave at the kill and which portions to transport to the processing area for further use. Such a selection procedure can be expected to be operative at sites, such as HSI, where the topography of the kill area is not conducive to conducting complete processing activities, but where a suitable area for these activities is close by and easily accessible. The second level of decision making takes place after the carcass portions have been transported to the processing site, and involves determination of how these remains will be further processed and ultimately discarded. We will discuss each of these two selection processes with the aim of shedding some light on the possible existence of patterned decision making selection procedures. It should be kept in mind that our view of intra-site selection is one-sided in that we are seeing this operation from the sole perspective of the processing area. A full comparison of this latter data base with the bone recovered by Reeves from the kill area would be most interesting but is prohibitive given the enormous sample of kill site fauna.

Two types of selections made at the kill site could be reflected in the archaeological record of the processing area. Preferences may be seen for animals belonging to certain age/sex classes, and secondary choices could be made for particular portions of the carcass.

Looking first at the evidence for preferential age/sex selection, the practise of hunting herds predominantly composed of one sex has been well documented in various ethnographies. Among bison hunters, cows were hunted in fall or early winter while bulls were preferred in late spring and early summer (Speth 1983:2). Two factors interplay in producing seasonal variation in preferred sex of the herds. In the fall and winter, herds were composed of cows, few bulls and calves, and separate herds of bulls. The cow and calf herds exhibit the gregarious behavior conducive to communal hunting and as such were relatively easy to hunt, and were in good physical condition. The bulls, having finished their rut, were in generally poor condition. In the spring and early summer, the opposite situation occurs. Cows are calving and are particularly aggressive in protecting their young. They are in the poorest condition of any time during the year. Bulls have been improving physically throughout the winter and early spring and are in prime pre-rut shape (Frison 1973:3-7, 1974:12-21; Speth 1983:1-2; Verbicky-Todd 1984:6-7). Seasonal sexual preference can be seen as the result of the interplay between ease of hunting and nutritional value.

There is an insufficient sample of seasonally sensitive elements at HSI to establish trends for seasonal use. The most promising seasonality indices seem to be the eruption and wear rates of bison teeth as applied by Frison (1970) and Reher and Frison (1980). Application of this technique, however, requires a large sample of well preserved mandibles with some of the teeth still in place. Such finds have been exceedingly rare in the processing area at HSI. Tooth and mandible fragments have been recovered in large numbers (see Table 20) but are invariably in extremely poor condition and unsuitable for seasonality analysis. Likewise, our sample of foetal bone is too small to permit a seasonal index. The use of foetal bone has been questioned in light of the documented out-of-season calving common to all bison herds (Arthur 1975; Haugen 1974; Reynolds et al. 1982).

Several problems were encountered in attempting to sex material from the processing area. The bison elements are highly fragmented, thwarting use of sexing techniques which require measures of complete length or shaft width. Sample size for any one element was inadequate. The most important uncontrolled variable was that the processing area is a product of multiple events. Any results would be a blend of two or more events. This blending of discrete uses of the processing area is an unfortunate but unavoidable aspect of the HSI faunal sample. Because of this blending, any patterns detected in sexual selection of carcasses to butcher and process must be somewhat suspect. Patterns could be artificial, not cultural, and caused by the compression of many uses of the site into a single analytical unit. Nevertheless, analysis must be attempted. Archaeological materials cannot be dismissed simply because they fail to qualify as "Pompeii" snapshots of the past. We can hope that over the thousands of years of bison killing at HSI, regular selection procedures existed and have left detectable evidence in the archaeological record. Interpretations of any such patterns must recognize the special circumstances of the HSI fauna.

Sexing techniques were applied to our most numerous limb elements, specifically the proximal metapodials, distal humerii and distal tibiae. The initial sexing results were combined to represent the front and rear limbs. The combined sample was large enough to assure statistically stable results. Discriminant function analysis was used to separate unknown material into male and female groups. The proximal metapodials were sexed on the basis of discriminant formulae generated by D. Walde (1985). These formulae were created as part of Walde's master's research which examined the problem of sexing the fragmented material from bison kill/butchering sites. Formulae for sexing distal humerii and tibiae were created by the HSI project. As this technique is extremely useful for zooarchaeological research, it is outlined in some detail below.

Discriminant function analysis assigns elements of unknown sex to male or female groups on the basis of criteria formed from the examination of known sex groups. The first step, and often the hardest in archaeology, is to find a large sample of elements whose sex is already known. Our sample was a composite formed from twelve Bison bison skeletons from the Archaeological Survey of Alberta, the University of Alberta, and the Provincial Museum of Alberta, plus data provided by Speth in the appendices of his book Bison Kills and Bone Counts (Speth 1983). The distal portions of the humerii and tibae provided the best compromise between large sample size and sexual sensitivity.

A series of measurements were taken which are thought to reflect sexually dimorphic variables. In our case, this choice was already made if we were to use Speth's data to maintain a large sample of known sex elements. Hence, the measurements used to formulate the HSI sexing formulae were identical to those used by Speth (1983), though we did not always use all of his measurements.

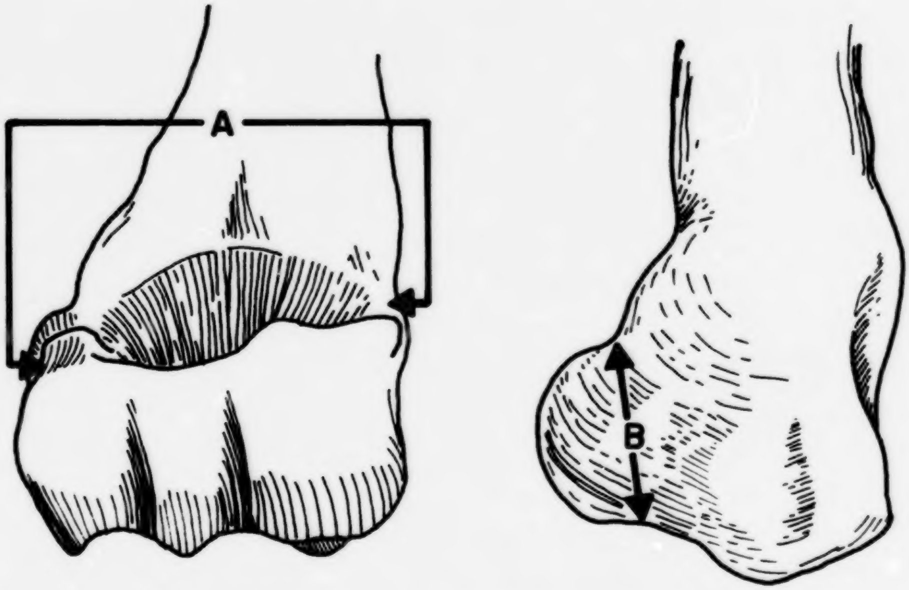
To derive discriminant function formulae by hand is extremely arduous. Fortunately, programs which will form these formulae are available in the mainframe statistical computer programs SPSSX and MIDAS. Although the mathematical concept behind discriminant function analysis is difficult for the statistical novice, it can be visualized as a multidimensional scatterplot. Each dimension of the plot represents a variable. If four variables are used to describe a skeletal element, the scatterplot has four dimensions. Each specimen of known sex is plotted through these four dimensions. Each sex group will cluster around its multidimensional mean, or centroid, if the variables used are truly sexually dimorphic. The distance between the centroids can be represented by a line. The length of this line, squared to eliminate negative values, is known as Malhalanobis' distance (D^2). The best discrimination between groups is established when D^2 is as large as possible. D^2 may be manipulated by adding or taking away variables. Variables which have a large range and correlate poorly with the single best discriminating variable decrease D^2 and are eliminated from the end product formula(e). Variables which display the opposite characteristics are good disciminators and are included in the formula(e). A line of best fit is drawn through each centroid. A modified form of these formulae of the lines are the discriminant formulae. Variables from an unknown specimen may be "plugged into" these formulae and the sex formula yielding the highest value is the group to which the unknown case is assigned.

The discriminant function formulae for distal tibiae and humerii are based on a known sample of 46 and 53 bone elements, respectively. Speth's data (27 tibiae and 30 humerii) were utilized to generate the discriminating formulae. The remaining measurements were taken from bison skeletons available in Edmonton and used as a sample to test the accuracy of classification. The positioning of the measurements used in constructing the discriminant function formulae are illustrated in Figure 87. Descriptions of how these measures should be positioned are available from Speth (1983:173, 179). These measures can be applied to the formulae shown in Table 17.

Table 17. Discriminate function formulae.

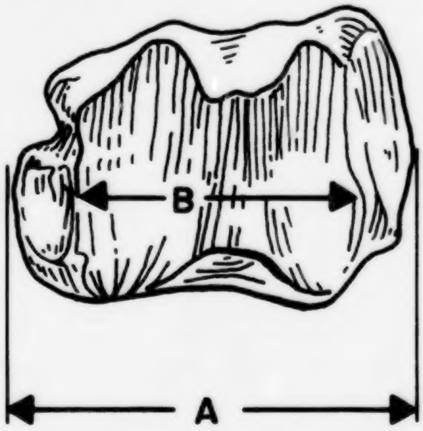
Element	Sex	Formula	Accuracy of Classification
Tibiae	Female	4.567(A) + 12.452(B) - 504.111	94.74%
	Male	3.911(A) + 11.228(B) - 396.009	
Humerii	Female	2.674(A) + 3.763(B) - 231.801	89.47%
	Male	2.349(A) + 3.129(B) - 169.882	

The unsexed mature limb elements from HSI consisted of 15 metatarsals, 15 metacarpals, 7 humerii and 24 tibiae. These archaeological specimens were sexed using Walde's formulae for metapodials and the HSI formulae for humerii and tibiae. The sexed sample was divided into right and left sides and the high side count for each sex was used to represent the minimum number of sexed individuals. This information is provided in Table 18.



DISTAL HUMERUS
(RIGHT), CRANIAL VIEW

DISTAL HUMERUS
(RIGHT), MEDIAL VIEW



DISTAL TIBIA
(RIGHT), DISTAL VIEW

Figure 87. Position of measurements used in discriminant function formulae (after Speth 1983:Appendix).

Table 18. Sexing results.

	Male	Female	Total
Metacarpal	3	7	10
Humerus	4	3	7
Metatarsal	6	4	10
Tibia	4	12	15
Total	17	26	43

The initial sexing results can be seen to fluctuate inconsistently. As the statistical sexing methods to classify all elements had a high reliability, the results were thought to be a consequence of small sample size. With this in mind, the data were combined to represent front and rear limbs. The high count for each element of the front or rear limb for each sex was used to represent individuals. These data are presented in Table 19.

Table 19. Combined sample of sexed front and rear elements.

	Male	Female	Total Limbs
Front Limb	4	7	11
Rear Limb	6	12	18
Total Sex Count	10	19	29

Table 19 shows similar sex ratios for front and rear limbs, with females outnumbering males approximately 2:1. Several factors could explain these results. Despite combining the front and rear elements, our results could still be a factor of a relatively small sample size. Assuming the strong female preference indicated by our results is a true reflection of the faunal universe at the HSI processing area, we may begin to question the processes which could produce this pattern. To the best of our knowledge, there is no documentation of natural processes which favour the preservation or destruction of bones of animals of certain sex. True, sexually dimorphic animals such as bison would be characterized by more robust - and hence perhaps more durable - bones for the male. Although we know of no literature which verifies this idea, if there is any truth to a tendency towards preservation of male bones, then our results may in fact argue for a stronger female bias than is indicated by the sexing data.

A further consideration when interpreting these data is the potential confusion of young male and elder female bones. Our selection of only mature bison limb elements attempted to control for this source of error. Unfortunately, the epiphyseal fusion rates of bison limb bones are largely unknown but are presumed to be highly variable (cf. Bedford 1978; Duffield 1973; Walde 1985). Hence, some bones will appear mature after a year or two, while others will appear immature until the individual is 6 to 8 years old. We have no direct control over this potential source of error except to postulate that our large sample of known sex bison used to produce the sexing formulae included a full range of mature limb bones for both sexes.

Finally, we may consider that the determined sex ratio from the area 2 block excavation is an accurate reflection of the sex of the animals processed over the course of a number of separate kill events. This, of course, may have no bearing on the sex ratio of the kill population. Speth (1983) convincingly argued for sexual selection from a bison kill population based on nutritrional condition of the various sexes in different seasons. Given our current knowledge of the HSI bone bed fauna, we are incapable of speculating on the sex ratio(s) of the original kill(s) from which the prehistoric hunters apparently culled for further processing a sub-population composed primarily of females. Our sexing results may indicate a repeated preference for female carcasses at a number of discrete kill events. If so, and if Speth's (1983) model of bison nutritional condition is correct, this would argue for repeated fall kills when females and calves are in prime physical condition. Alternatively, our results could be explained by a mixture of seasonal kills each dominated by lopsided sex ratios but, overall, imparting a female bias to the faunal remains of these events. In fact, a great many communal hunting scenarios are possible to account for the observed data. In the absence of stratigraphy and temporal controls, none can be confidently ruled out. Nevertheless, our strong bias towards female carcass selection, if a true representation of cultural selection, is consistent with a number of tangential arguments. First, plains Indian ethnographies repeatedly mention the fall as the season of communal hunts designed to store surplus food for the winter months (Ewers 1958; Wissler 1910; also see McHugh 1972; Roe 1972; Verbicky-Todd 1984). Second, Frison has argued that the archaeological record from many northern plains bison kills supports the written accounts in that they are attributable to late fall/early winter events (Frison 1967, 1970, 1973, 1974, 1978; Reher and Frison 1980). Third, the arguments mentioned above by Speth (1983) would predict a high incidence of females killed in the fall/early winter due to their enhanced physical (i.e., nutritional) status vis-à-vis males. There are many "ifs" to accept in the above line of thinking, and there are alternative points of view which are not being explored here. However, it can at least be suggested that the female bias in the limb bones from the HSI processing area may be the result of a sequence of fall kills.

Attention can now be turned to the second intra-site selection process, that being the question of which carcass portions are transported from the kill site to the processing area. It will be recalled that the topography of the HSI kill is such that we would postulate movement of animal portions to the more level ground of the processing area. This being the case, one can predict that not all carcass portions will move from the kill. The size of the animals would have required some initial butchering in order to produce a transportable segment. In so doing, one would expect decisions to be made as to elements considered worthy of further attention and those regarded as of no value. In other words, we can suggest that the prehistoric hunters evaluated a kill population from the perspective of its further utility or value, either as a food source or as a source of other desirable commodities. This method of examining site fauna has been primarily developed and utilized by Binford (1978, 1981a). Binford has argued for a maximizing view of prehistoric subsistence strategies whereby the partitioning and use of a carcasses is the result of rational decisions based on the utility of carcass portions as food sources. So far, Binford has not considered evaluating non-food uses of animals using a similar methodology.

The application of Binford's utility methodology to faunal analysis is relatively simple in itself, but the underpinnings of the methodology are fraught with potential problems. These are now being discussed in the literature and cannot be considered in full review here. Briefly, Binford (1978) calculated indices of carcass portion utility for caribou and sheep based on meat, marrow and grease quantity and quality. These indices in theory measure the desirability of certain carcass elements as food sources under certain conditions. As such, they have predictable consequences in the archaeological record. At a kill site, for example, much of the remaining fauna would be from the least desirable (low utility) items, while the more useful elements would have been removed or processed and, hence, would be conspicious by their scarcity. This simple idea has many complicating factors, such as the logistical considerations of the hunters, the location of the kill vis-à-vis a campsite, the time of year and mode of travel, and so on. Partitioning mammal carcasses into analytical units also poses many problems. Binford, for example, identifies "riders", or those elements (usually small) which may be low in food utility but which may travel with higher valued items simply because it is not worth the hunters' time to remove them.

Binford's method of viewing faunal remains as the output of logical decision making regarding food utility of animal carcass portions has come under serious attack. Clearly, his sample size of carcasses used to formulate the utility indices was, in his own words (Binford 1984:13), miserable. The applicaton of indices to animals other than sheep and caribou is unknown (cf. Speth 1983). The various calculations used to arrive at many of the indices have been questioned (Will 1985). More specifically, since Binford figures the variable density of specific faunal elements into his indices, his method of determining bone density and, hence his resulting indices, have been seriously criticized (Lyman 1984, 1985). In short, Binford has introduced a provocative new means by which to view archaeological fauna. Problems with the methodology are to be expected, but the idea of examining faunal remains from the point of view of a utility concept seems worth attempting. Several recent faunal studies have employed the concept - if not the method - and have produced results suggestive of overall merit to the approach (Speth 1983; Thomas and Mayer 1983; Will 1985).

As with all other analyses attempted to date with 1984 HSI materials, the application of a utility concept analysis to the 1984 fauna is plagued with the same problems resulting from collapsed occupations, the ravaged nature of the assemblage, lack of temporal control, etc., as have already been discussed. In spite of these obstacles, we felt it appropriate to at least attempt the analysis. The reader should bear the same caveats in mind, however, as discussed above.

As mentioned, there are as yet no utility indices specifically formulated for bison. Until such are available, we will have to employ Binford's indices as currently available. Further, adopting Binford's (1978) tenet that fauna served primarily as food is inappropriate when examining a plains bison kill site, given the ethnographically recorded use of these animals for an enormous array of non-food purposes (cf. Ewers 1958). Nevertheless, in order to apply the method, this assumption will be maintained.

At HSI, we are presumably dealing with a situation where there is a kill locus and a separate processing area; therefore, a straightforward application of Binford's utility indices is not possible without examination of both loci. Since our work has only examined the latter of the two areas, some limitations to Binford's methodology must be adopted. The partitioning of the site reflects partitioning of butchering activities of bison. The initial killing would have been followed by some degree of primary butchering prior to removal of portions downslope to be further processed. In so doing, much of the decision making relevant to Binford's meat utility index would have transpired. Activities and residues associated with the marrow and grease indices would presumably be located primarily in the processing area. These latter activities procedurally follow initial butchering and are destructive in that, to remove bone marrow or render bone grease, one must largely destroy the primary faunal evidence pertaining to the meat index. This procession or chain of rendering activities makes it unlikely that the archaeological record from the processing area will permit application of the meat utility index. We can, however, search for evidence of the latter two measures of utility.

Primary butchering is the process of separating useful portions of the animal from extraneous parts at the location of the kill. Secondary butchering refers to the further refining of these useful portions in a processing area. Frison's summary of butchering and processing techniques from Piney Creek states:

> Hind legs were transported to the butchering area where the pelvic bones were removed by breaking the head of the femur, presumably after the meat had been stripped away ... There was little or no utilitarian use for scapulae and many of the larger ones, remained at the kill area ... Skull, vertebrae and proximal ends of ribs were left in the kill area (Frison 1967:33).

Frison's description allows us to build a model of skulls, vertebrae, proximal rib portions and large scapulae as primary elements and the appendicular elements, rib shafts and sternebrae as secondary elements. Frison also shows vertebral projections consistently broken away at the kill site, and the caudal vertebrae and the last two or three sacral elements were transported with the hides (Frison 1967:33). We can further refine this model to classify skulls, centrum of the vertebrae (excepting the tail elements), large scapulae and proximal portions of the ribs as primary elements, vertebral projections as indeterminate and the remainder of the skeleton as secondary elements. This breakdown would yield 47 elements or portions of elements as left in the kill area and 111 elements or parts of elements (based on a mature skeleton) as transported to the processing site. This is equivalent to a ratio of 3 primary parts to 7 secondary elements.

Assuming a selection process similar to that outlined above, the processing area should contain considerably fewer primary elements. If the processing area contained all portions of the bison carcass (i.e., 3 primary to 7 secondary elements), an index of .42 (i.e., 3/7) would result. A lower index would indicate a selection for specific skeletal elements consistent with Frison's hypothesized butchering sequence and in keeping with the concept of selection for food utility.

The material was initially summarized by NISP count for area 2 (Table 20). It was necessary to modify the NISP scores to better reflect

Table 20. Bison element count for area 2 (NISP).

Element	n	%
Skull	333	9.9
Mandible	177	5.3
Hyoid	4	.1
Axis	13	.4
Cervical Vertebra	121	3.6
Thoracic Vertebra	109	3.2
Lumbar Vertebra	25	.7
Sacrum	4	.1
Caudal Vertebra	10	.3
Ribs	393	11.7
Pelvis	41	1.2
Scapula	153	4.5
Humerus	140	4.2
Radius	138	4.1
Ulna	50	1.5
Scaphoid	41	1.2
Lunate	25	.7
Cunisform Manus	27	.8
Pisiform	6	.2
Magnum	36	1.1
Unciform	12	.4
5th Metacarpal	1	.0
Femur	78	2.3
Patella	22	.7
Tibia	140	4.2
Lateral Malleolus	23	.7
Astragalus	82	2.4
Calcaneus	75	2.2
Navicular Cuboid	51	1.5
Cuniform Pes	35	1.0
Metacarpal	135	4.0
Metatarsal	127	3.8
Metapodial	97	2.9
1st Phalanx	167	5.0
2nd Phalanx	144	4.3
3rd Phalanx	48	1.4
Proximal Sesmoid	54	1.6
Distal Sesmoid	22	.7
Longbone fragment	15	.4
Upper Molar	64	1.9
Incisor	17	.5
Lower Molar	61	1.8
Indeterminate	54	1.6
TOTAL	3370	100.0

elements present in the processing area if a primary to secondary element ratio was to be ascertained. Raw NISP scores were misleading due to the high degree of faunal fragmentation at HSI. This degree of fragmentation results in an over representation of large, thin elements. The in situ evaluation of highly fragmented pieces did assist in reducing some of this bias in NISP estimates. In other cases, the count of individual elements had to be estimated by using the highest count of one portion of an element. In some cases, it was impossible to determine a count for an element. For example, no estimate could be made of rib shafts or vertebral projections because they were shattered and scattered throughout the block excavation.

Once an estimation of element count had been completed, the results were simplified by calculating an MNI count for each element. This was done by computing the highest side count for each portion used to represent a particular bone. Multiple occurring elements, such as ribs and vertebrae were divided by the number of times they occur in one side of the animal. These manipulations resulted in a hypothetical skeleton in which each element occurs once. This allows direct comparison of all elements found in the processing area. Since there was no information to counter the belief that the carpals and tarsals would remain intact as riders transported to the processing area, only the highest count for a single carpal and one tarsal was employed.

These modifications change the hypothetical butchering index. Nine primary portions to 18 secondary butchering portions yield an index of .5 for a processing area in which all portions of bison were consistently transported. Only 8 primary portions to 16 secondary portions can be discerned at HSI using MNI counts for elements because of taphonomic damage but the critical index remains .5 (i.e., 8/16) if transport from kill to processing area was unbiased.

Examining the 1984 data, MNI scores for elements are presented in Tables 21 and 22, and yield an index of .17 (27/161). This shows a strong selection for secondary elements as prescribed in the working model. The presence of some primary elements in the processing area has been explained in two ways by Frison: animals which were mortally wounded in the fall may have escaped only to die or be killed in the processing

Table 21. Primary bison element counts (MNI).

PRIMARY ELEMENTS	n	%
Skull	4	14.9
Mandible	11	40.9
Hyoid	2	7.4
Axis	2	7.4
Cervical Vertebra	3	12.7
Thoracic Vertebra	2	7.7
Lumbas Vertebra	1	4.5
Sacrum	1	2.2
Ribs	1	2.2
TOTAL	27	100.0

Table 22. Secondary bison element counts (MNI).

SECONDARY ELEMENTS	n	%
Pelvis	6	3.7
Humerus	17	10.6
Radius	16	10.0
Ulna	13	8.1
Scaphoid	10	6.2
Femur	4	2.5
Tibia	18	11.2
Astragalus	24	15.0
Metacarpal	12	7.5
Metatarsal	14	8.7
1st Phalanx	11	6.7
2nd Phalanx	12	7.4
3rd Phalanx	4	2.4
TOTAL	161	100.0

area; alternatively, smaller animals such as calves and yearlings may have been transported whole to the processing area (Frison 1967:31).

If the mechanism that resulted in primary elements being represented in the processing area was the downslope transportation of whole calf carcasses, then we would expect an over abundance of these primary elements to be from immature animals when compared to the secondary elements. To test this hypothesis, a Chi-square test of mature to immature elements was calculated for a primary and a secondary element. Epiphyseal fusion was chosen as an indicator of maturity. Rib heads were used to represent primary butchering elements and first phalanges were taken as secondary butchering items. Precise fusion times are unknown for these items, but both are believed to fuse early in life. Table 23 shows the contingency table for selected mature and immature items. The Chi-square test supports the hypothesis of proportionally more immature primary elements than secondary elements in the processing area. These results lead to the suspicion that young animals are butchered differently than older, larger animals, but the lack of firm epiphyseal fusion rates for bison thwarted any confirmation of this hypothesis. Tentatively, we would suggest that calves, and possibly yearlings, were

Table 23. Contingency table for immature and mature elements

Element	Immature	Mature	n (%)
Rib Head (primary)	3	10	13 (18.1)
First Phalange (secondary)	2	57	59 (81.9)
TOTAL	5 (6.9)	67 (93.1)	72 (100.0)

CHI-SQUARE	D.F.	SIGNIFICANCE
3.70585	1	0.0542
6.38919	1	0.0115

often transported whole from the kill site with little or no primary butchering.

A final consideration of intra-site selection and processing of carcass portions goes beyond the stripping, consumption and preservation of meat to the processing of bone elements. Two food procurement techniques are examined in this section: bone degreasing and marrow extraction. Bone degreasing is the process of smashing bone and boiling the fragments to release the grease (Leechman 1951). This grease is a very nutritious food substance which may be stored or mixed with meat and berries when making pemmican. Marrow extraction involves breaking the long bones and removing the marrow from the medullary cavity. Marrow could have been eaten on the spot or may have been incorporated with the bone grease and used when making pemmican.

Bone degreasing is a destructive process and evidence of this activity is inferred through an absence of the preferred portions of the skeleton. Binford (1978:34) has that argued an aboriginal preference exists for one type of grease, white grease, found in quantity in the long bones of large land mammals. White grease is found in the appendicular portions of the skeleton, especially the articular ends of the limb bones. Binford (1978:32-38) has constructed grease indices for caribou based on the quality and amount of grease relative to the ease of retrieval. HSI data for bison long bone ends was compared to Binford's indices to explore the relationship between the absence of articular portions of long bones and preferential selection for degreasing. Binford created white grease indices for all elements in the appendicular skeleton but found that the Nunamiut refused some elements with a predicted high value because they were simply too small. All of the "riders" of the appendicular skeleton (the tarsals, carpals and phalanges) are found intact and in large numbers, and thus were not part of the degreasing process. Because they play little or no part in this process, they have been omitted from the comparison of missing limb portions versus valued grease elements. Binford's grease index is thus a ranking of skeletal portions (e.g., proximal tibia, distal metacarpal) in accordance with the quantity, quality and availability of bone grease as determined from laboratory studies. If the proportional amounts and distribution of bone grease in bison is similar to that measured by

Binford, and if prehistoric hunters indeed consciously selected for bone elements using such criteria, we could then expect a patterning to the HSI faunal assemblage consistent with that predicted by Binford's index.

Long bones were ranked in order of preference as predicted by Binford's white grease index (BIN=) and compared to an inverse ranking of the frequency (MNI) of long bones recovered from the processing area (HSI=). This inversion of rank was done on the assumption that any portion of bone used for degreasing would be missing from the faunal assemblage. That is, the grease rendering process is destructive in nature and results in the absence of those bones from the archaeological record. The results of this ranking and raw scores are presented in Table 24.

Table 24. MNI count and rank order of white grease indices.

Element	Complete	Proximal	Distal
Humerus	-	HSI=1 BIN=2	29 HSI=11 BIN=8
Radius	-	21 HSI=7 BIN=6	21 HSI=7 BIN=8
Metacarpal	3	24 HSI=9 BIN=12	15 HSI=5 BIN=5
Femur	-	12 HSI=4 BIN=9	1 HSI=2 BIN=1
Tibia	-	1 HSI=2 BIN=3	31 HSI=12 BIN=10
Metatarsal	1	24 HSI=10 BIN=11	15 HSI=5 BIN=4

The results show an excellent correlation between the predicted use of elements as derived from Binford's indices and those element portions missing from the assemblage. The results can be interpreted as an indication of intensive utilization of highly valued ends but comparatively less processing of the less valued portions. The only striking exception to the predicted use of bone was the proximal femur. The white grease utility index predicts that this would be a desirable element for decreasing and hence poorly represented in the assemblage, yet it was relatively common at HSI. Raw scores indicate its high value to the users of the jump, but it is not utilized to near the degree of the proximal humerus, tibia or distal femur. This difference could be the result of dissimilarities between bone grease in bison and caribou. Alternatively, this discrepancy may be a reflection of sampling error. A final possibility rests with the fact that many of the proximal femur identifications consisted of nothing more than the ball end of the articular surface. This relatively hard bone may have been ignored during the process of pulverizing the remainder of the proximal femur for degreasing.

Consistent use of high value items and only partial use of low value items suggests that bone degreasing was undertaken in the processing area. This interpretation is consistent with the evidence of grease rendering consisting of massive amounts of fire broken rock and numerous pit features. However, simple acceptance of the fit between our data and Binford's index ignores many potentially confusing variables. Specifically, the same pattern of element representation can be caused by means other than cultural selection. Most obviously, carnivores can be postulated to preferentially attack those very same bones - those hignest in grease content and most readily broken down - as would prehistoric hunters. Particularly hard elements (e.g., the condyle of the distal humerus) would often be bypassed by both man and carnivore. The pattern observed in Table 24 would be a result of selective consumption by either or both of these agents. Likewise, natural weathering of bone would be biased towards the less dense elements, tending over time to leave only the harder elements. This selection could also mimic the pattern produced by hunters involved in grease rendering. Ideally, the faunal assemblage from a site would be shown to have not suffered from these various taphonomic effects. Only in such cases can the resulting element patterning be more confidently attributed to the actions of cultural agencies (e.g., Speth 1983). As discussed in this and previous reports (Brink et al. 1985), the HSI faunal assemblage from the processing area is the antithesis of an unravaged assemblage. Hence, our promising fit with Binford's grease utility index may have been produced by a number of separate agencies, or several in combination.

Calculation of preferred items for marrow extraction is much more complex than those for bone degreasing. Whereas simple element presence or absence can be used to argue for grease rendering, marrow extraction can only be inferred from green (fresh) bone breaks found on the shafts of long bones. These breaks also may result from carnivore activity. In addition, various taphonomic processes have obscured the broken ends of many limb elements. It is not possible to tell whether these breaks were the result of intentional marrow extraction or other agencies such as carnivore activity. A final confounding variable is the bone degreasing practice which totally destroys any evidence of bone originally broken to remove the contents of the medullary cavity.

Green bone breaks were assessed according to criteria developed by Morlan (1980). Bone which exhibited these breaks was inspected for evidence of carnivore gnawing. In no case could scavenger activity be identified, but neither could depression fractures associated with intentional bone breakage. In order to pursue the analysis of bison processing, we will utilize these data in a comparison with Binford's marrow utility index. Unfortunately, our sample of bones is very small (n=27) and insufficient for the detailed assessment of marrow processing activities at HSI.

Green bone breaks were subdivided in a contingency table by element and portion of element (NISP). These data were compared to a ranking of preferred elements for marrow extraction based, again, on Binford's work with caribou (1978:23-32). Elements with high values (preferred portions) were those which gave the largest quantity of higher quality marrow per unit time invested. A comparison of the HSI material with predicted order of preference shows some degree of correlation despite the many confounding variables (Table 25). Items with a predicted low value are all present in the assemblage, while items of high value tend

Table 25. NISP count and rank order of marrow indices.

ELEMENT	SHAFT	PROXIMAL	DISTAL
Humerus	1	- HIS=9 BIN=11	1 HSI=12 BIN=12
Radius	-	3 HSI=3 BIN=9	2 HSI=4 BIN=5
Metacarpal	-	2 HSI=4 BIN=8	2 HSI=4 BIN=2
Femur	-	- HSI=9 BIN=7	- HSI=9 BIN=10
Tibia	1	- HSI=9 BIN=8	9 HSI=1 BIN=2
Metarsal	1	4 HSI=2 BIN=3	1 HSI=7 BIN=1

to be absent. The actual scores from the HSI site are seen to fluctuate, and this is probably a result of small sample size.

Clearly, the loose correlation between our recovered fauna and Binford's marrow index is, at best, only suggestive. The very small sample size, plus the poor condition of the bone prohibits more secure conclusions. As discussed during the above consideration of grease rendering, natural forces could also mimic the hallmarks of marrow extraction by human hunters. At present, our analyses can do no more than suggest that cultural processing is one of the several potential causes of the observed faunal patterning.

Area 12 Faunal Remains

Test excavations were undertaken in this southernmost part of the HSI processing site to mitigate the installation of the main parking lot for the visitor reception centre (see Figure 2). Previous testing in 1983 was also motivated by mitigative requirements and resulted in a widely dispersed sampling of the area's cultural deposits. The results of the 1983 test excavations indicated that a thin, discontinuous late prehistoric cultural deposit occurred in association with the near level topographic surfaces of the site, and that faunal remains were few in number and poorly preserved. These results, coupled with the large distance to the kill site (c. 800 m), prompted the identification of this deposit as a peripheral zone of the processing site. We also suspected, based on the variety of bone elements recovered and the presence of carnivore remains, that some of the bone from area 12 had actually been scavenged from the kill site. We therefore anticipated that the more limited excavations of 1984 would reveal similarly structured deposits and, for the most part, our expectations were fulfilled.

As predicted, excavation units on the level site surfaces revealed a thin cultural deposit and few faunal remains (units 5 and 6); however, two units located in a drainage channel yielded deeply buried, well preserved faunal remains and evidence of in situ cultural activities (units 7 and 8, see Figures 3 and 4). A discussion of the excavation methodology, depositional context and interpretation of the area 12 deposits has been presented elsewhere (see Chapter 2); the purpose here is to provide a detailed review of the kinds of faunal remains recovered from the deeply buried deposits of area 12.

A total of 2021 identifiable bone elements were recovered from the test units located in the drainage channel in area 12 (see Figure 3). Only one percent of these remains were non-bison (see Table 16); the detailed breakdown of the bison elements is presented in Table 26. It is evident that the majority of this assemblage consists of skull fragments (70%), and that the NISP count belies the actual number of bison represented. Certainly, the context of the remains and evidence for articulated portions suggest that several individual bison were killed and processed. However, the type of processing appears to differ substantially from that which characterizes the core processing area. That is, there appears to be more whole bone and a more complete representation of the skeletal elements in this section of area 12,

Table 26. Bison elements recovered from units 7 and 8, Area 12 (NISP).

ELEMENT	FREQUENCY	PERCENT
Skull	1394	69.7
Mandible	15	0.7
Axis	14	0.7
Cervical Vertebra	22	1.1
Thoracic Vertebra	58	2.9
Lumbar Vertebra	10	0.5
Sacrum	4	0.2
Caudal Vertebra	1	0.1
Ribs	93	4.6
Pelvis	49	2.4
Scapula	55	2.7
Humerus	35	1.7
Radius	17	0.8
Ulna	22	1.1
Scaphoid	2	0.1
Lunate	3	0.1
Cuniform Manus	5	0.2
Pisiform	2	0.1
Magnum	3	0.1
Unciform	5	0.2
Femur	16	0.7
Tibia	41	2.0
Lateral Malleolus	2	0.1
Astragalus	11	0.5
Calcaneus	8	0.4
Navicular Cuboid	4	0.2
Cuniform Pes	10	0.5
Metacarpal	17	0.8
Metatarsal	16	0.8
Metapodial	5	0.2
1st Phalanx	6	0.3
2nd Phalanx	10	0.5
3rd Phalanx	9	0.4
Proximal Sesamoid	4	0.2
Distal Sesamoid	3	0.1
Longbone fragment	2	0.1
Upper Molar	21	1.1
Incisor	5	0.2
Lower Molar	2	0.1
TOTAL	2001	99.9

suggesting that the remains were not transported from the kill site and are, therefore, not comparable with the area 2 processed remains.

The significance of the area 12 remains was initially premised on their deep burial, but C-14 assays on the bone from these deposits indicate that depth is not a good index of prehistoric time depth for this particular area of the processing site (see Table 1). A cursory examination of the assemblage failed to reveal obvious butchering marks, despite the well preserved nature of the bone surface. The negative evidence for butchering marks, well preserved element portions, and lack of artifactual remains may be taken as evidence of the minimal extent of processing undertaken in this particular area of the site. These remains from area 12 are, at present, anomalous with respect to the majority of the processing site deposits at HSI. Although these remains cannot be used in a comparative fashion, they do provide an interesting and significant glimpse into alternative bison processing strategies that were periodically undertaken at HSI. The integrity of these deposits was ensured by modifying the configuration of the main parking lot so as to avoid any impacts.

Other Species

Only six species were represented at HSI, excepting Bison bison and various intrusive rodents. Three species of canids, a mule deer (Odocoileus hemionus), a hare or rabbit, and a beaver were identified in the faunal assemblage. The hare/rabbit (Lepus sp.) and beaver (Castor canadensis) were represented by one element each, and no information could be discerned about their relationship with the cultural history of HSI.

Canids were dealt with extensively in the 1983 final report for HSI (Brink et al. 1985). This year, we had no elements which were species diagnostic. Species assignment was based on the size of mature elements and, thus, species identification may be regarded as tentative at best. Table 27 gives a breakdown of NISP by species. One wolf (Canis lupus), three dogs (Canis familiaris) and one coyote (Canis latrans) are thought to be represented. The use of dogs as food among the plains Indians is documented in Verbicky-Todd (1984).

Table 27. NISP for canid remains, all areas.

A) *Canis lupus* (Wolf)

Element	n	%
Radius	1	12.5
Calcaneus	2	25.0
Cuniform Pes	1	12.5
1st Phalanx	1	12.5
2nd Phalanx	2	25.0
Lower Molar	1	12.5
TOTAL	8	100.0

B) *Canis latrans* (Coyote)

Element	n	%
Ribs	2	20.0
Humerus	6	60.0
Astragalus	1	10.0
Upper Molar	1	10.0
TOTAL	10	100.0

C) *Canis familiaris* (Dog)

Element	n	%
Cervical Vertebra	1	1.7
Thoracic Vertebra	1	1.7
Ulna	3	5.2
Cuniform Manus	1	1.7
Metacarpal	3	5.2
Metapodial	2	3.4
1st Phalanx	4	6.9
2nd Phalanx	1	1.7
Upper Molar	1	1.7
Lower Molar	1	1.7
Partial Skeleton (foetal)	40	69.0
TOTAL	58	100.0

The remains of a mule deer (Odocoileus hemionus) are represented by an antler in the processing area and it appears to have been worked (see analysis of bone tools, Chapter 3). No skull or other elements could be found, so it is likely that the animal was killed away from the site or the antler was shed and brought to the site as a tool blank.

Backdirt Sampling

There can be little argument that the composition of an archaeological assemblage is a direct result of the recovery methods employed during excavation. Recovery methods include the means employed in excavating the matrix, selection of a screen mesh size and establishing criteria for the collection of items retained within the screen. Previous evaluations of recovery methods employed at HSI have demonstrated that significant numbers of items are missed when using standard 1/4 inch mesh (see Brink et al. 1985:237-241). For example, an analysis of debitage recovery bias suggests that 91% of the lithic remains at HSI are not recovered using 1/4 inch mesh. Similarly, the number of bone fragments missed is estimated to be well in excess of 95% of the total bone present. Despite their magnitude, these recovery biases are not considered significant, and in most instances, are similar to, or slightly better than, the recovery biases associated with most archaeological excavations. It is clear, therefore, that much of the bone and lithic remains present in the HSI site deposits are never recovered, but does this recovery loss seriously compromise the validity of our archaeological interpretations?

We suspect that such recovery biases are unimportant, for these kinds of remains are not likely to contribute substantively to the site interpretation. For example, we know from the nature of the recovered lithics that core reduction and tool maintenance activities were conducted throughout the camp and processing site area. By obtaining the extremely fine fraction remains associated with these activities, we only confirm that which is indicated by the extant assemblage. Similarly, with bone elements largely forming a continuous deposit in the upper 20 cm of the site sediments, it is predictable that small fragments would be prolific. These fragments were a focus of our previous season's analysis (Brink et al. 1985:183-191), and we determined that they most probably resulted from the taphonomic reduction of larger element portions through weathering and trampling. Thus, there appeared to be little value in continuing to collect these kinds of data in 1984 given the onerous expenditures of time and labour involved in collecting, cataloguing and analysing these remains, as contrasted with the minimal analytic return.

The recovery strategy adopted in obtaining the 1984 faunal assemblage has been outlined earlier and, as part of this methodology, we elected to sample some of the backdirt from selected excavations units to determine the data loss associated with this methodology. We were particularly interested in determining whether the size of the bone fragments was comparable to our 1983 results, based on the assumption that taphonomic reduction occurs uniformly throughout the site and results in a similarly sized assemblage of bone fragments.

The backdirt from excavation units within the block excavation was maintained in a mutually exclusive manner and non-identifiable bone from the faunal lab was returned to the appropriate backdirt pile. Once the excavation unit(s) were completed, the backdirt pile was mixed by shovelling the centre of the pile out and shovelling the margins of the pile into the centre. Buckets of earth were then taken from the cardinal points of the pile midway between the base and the top of the pile. A total of five samples were obtained from three discrete backdirt piles; we estimate that these 52 litre samples represent, on average, about 3% of the total volume of backdirt present. All samples were processed by screening through nested sieves in accordance with our previous study (Brink et al. 1985), and the amount of bone in each sieve was weighed to arrive at a sample proportion. The results of this analysis are presented in Figure 88.

The five samples are structured as follows: one and two are separate samples of the same backdirt pile; likewise, samples three and four are derived from a single backdirt pile and sample five is from a third backdirt pile. In this way, it is possible to compare both the range of variation in bone fragment size between backdirt piles, as well as checking on the consistency of our sampling technique within individual backdirt piles.

None of the bone recovered from the backdirt samples was identifiable below the level of class (i.e., mammal), although it is safe to assume

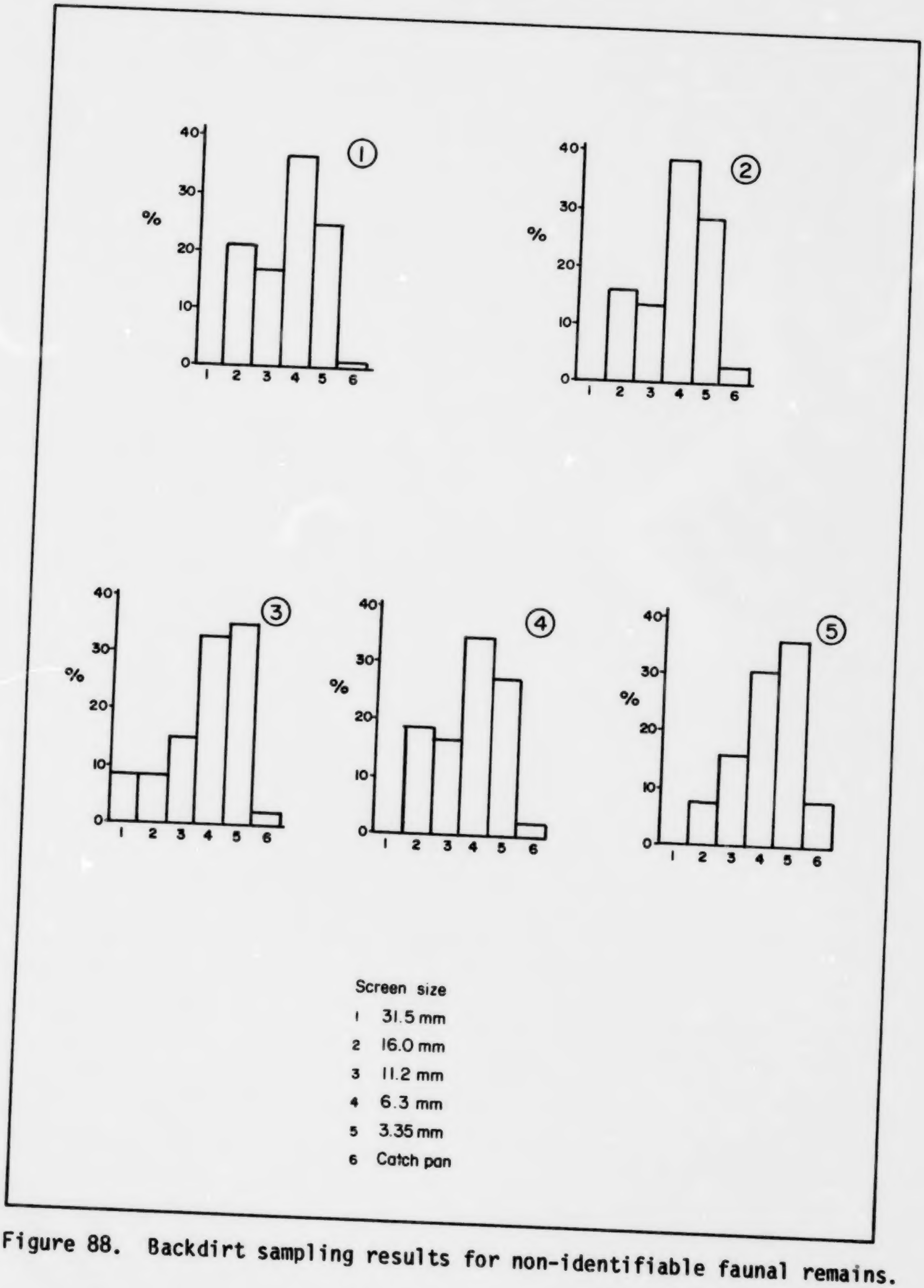


Figure 88. Backdirt sampling results for non-identifiable faunal remains.

that fragments of large mammal bone are ultimately assignable to Bison bison. The only exception to this latter generality was the periodic recovery of small rodent bones, which are to be expected in the context of the burrow-riddled camp and processing site deposits. Returning to Figure 88, it is evident that all of the samples are similarly structured and that the majority of the bone always occurs in the fourth and fifth size classes. This result is totally consistent with the findings of our 1985 analysis (Brink et al. 1985). There is excellent agreement between samples one and two, thus confirming the consistency of our sampling technique. There is not the same degree of homogeneity between the third and fourth samples which represent the same backdirt pile. It is worth noting that the difference is in the larger size categories, and that the presence of a single bone could significantly alter the weight distribution of the histogram. Overall, the two samples are not viewed as being notably different and yield essentially compatible results. The distribution revealed in sample five is the ideal depiction of what we would interpret as a taphonomically altered bone assemblage, that is, a distribution that is right skewed. If these distributions were calculated on the basis of count, as opposed to weight, the skewing would be particularly acute.

The results of the backdirt sampling exercise were largely predictable based on our previous year's experience with the HSI deposits. It was gratifying, however, to demonstrate that discarding the non-identifiable bone assemblage has in no way compromised our faunal analysis and interpretations, while at the same time reducing substantially the time and labour required to collect, sort and accession these kinds of remains.

SPATIAL PATTERNING

Introduction

This section is concerned with the analysis of intra-site spatial patterning and the identification of contextual relationships among the archaeological data recovered from the block excavation. On the basis of the foregoing analyses, it can be confidently stated that a variety of tool making activities, secondary butchering activities and tasks involving the processing of bison remains (i.e., marrow and bone grease processing, meat stripping and drying, boiling and roasting of meat portions, etc.) were conducted in the area of the block excavation. It is also clear that some of these activities must have been associated with the features recorded within the block excavation, but the exact nature of this association has yet to be determined. The analysis of spatial patterning thus has two objectives: 1) to delimit the horizontal extent of activity areas within the block excavation; and, 2) to characterize the archaeological residues that make up those activity sets.

Although activity areas and activity sets are conventionally associated with the spatial analysis of tool distributions (Carr 1984:114), this analysis focusses on non-tool remains, notably FBR and faunal distributions. By analysing these kinds of remains, we hope to achieve a better understanding of how the proceeds of the kill site were converted into consummable and storable foodstuffs in the setting of the camp and processing site. The processing of literally thousands of kilograms of bison meat and by-products was the main activity at HSI for several thousand years and, while stone tools were no doubt essential to some of the processing tasks, they are only an indirect reflection of this activity. The remains of FBR, bison bone and features are, on the other hand, a more direct reflection of these processing tasks and they pervade the deposits of the camp and processing site. Furthermore, the contextual integrity of the HSI deposits is such that detailed study of lithic artifact distributions would be of questionable utility. The minimum provenience available is too coarse to facilitate detailed studies. The minimum provenience of a 50 cm^2 x 10 cm deep subquad was established in recognition of the fact that the HSI deposits are both stratigraphically collapsed and subject to extensive post-depositional disturbance (Schiffer 1983). These two processes affect all of the remains in the processing site, but we assume that the magnitude of this disruption is inversely proportional to the original size of the activity area. That is, the context of a small scatter of lithic debitage is more easily disrupted than an assemblage of several bison bone elements in association with a boiling pit and several kilograms of fire broken rock. We assume, therefore, that the absolute size and robust nature of the materials associated with a given activity area will help to ensure that some contextual integrity survives despite post-abandonment disturbance.

The discussion which follows outlines some of the conceptual, methodological and interpretational issues that arose in the course of the HSI analysis. The results are then presented in two parts: the separate evaluation of FBR and faunal distributions in comparison with features. Features, by definition, are in situ and thus provide a reference point for the evaluation of other remains whose context is less secure. Obviously not all of the features in the block excavation were in use simultaneously, and the context alluded to above refers only to the immediate zone surrounding the feature. Context is an integral component of spatial analysis, but it is not essential that all remains be in primary, or pristine context (cf. Binford 1981b). It is simply cautioned that the further the remains are removed from features and other residues, the more difficult it becomes to argue effectively for a relationship between these remains. The use of visual pattern assessment as opposed to modeled comparisons in the evaluation of the HSI data makes it particularly important that the contextual relationships being advanced be both plausible and obvious to any observer.

Site Formation and Taphonomic Processes

The archaeological deposits of HSI can be divided into two components: the kill site and the camp and processing site. The activities conducted in each of these areas are presumed to have been distinctly different and the residues deposited by each set of activities are therefore also presumed to be distinctive. There is also a difference in the way in which these deposits have accumulated through time and this, in large part, determines the resolution of our archaeological interpretations.

The kill site can be termed an episodic deposit; that is, each layer of bone is largely representative of a single event which, ideally, is separated from subsequent events by sediments derived from the cliff face. These stratified deposits form a detailed record of the events associated with the kill and allow for a "fine grained" analysis of site formation processes (cf. Reher and Frison 1980; Thomas 1983:438).

The concept of a grain size for archaeological deposits was introduced by Binford (1980:17). This principle holds that archaeological residues have structural characteristics that control the kinds of information that may be extracted from the archaeological record. For example, in contrast to the kill site deposits, the camp and processing site residues at HSI are accurately termed a coarse grained deposit. That is, these are deposits which have built up as a result of separate events (i.e., fine grained, much like the kill site), but minimal sedimentation rates have left these deposits superimposed, and indistinguishable as separate events. Such deposits are notoriously difficult to interpret, for not only are a series of discrete events superimposed, but there is often disturbance of the earlier deposits by virtue of the newly formed deposits. This disturbance could involve the trampling of exposed bone, recycling of FBR, recycling of tipi ring rocks, reuse of abandoned feature depressions, and construction of new pits, hearths, drying racks or hide preparation facilities, all in the midst of previously discrete archaeological residues. Furthermore, once the site is abandoned, a variety of taphonomic agencies initiate further disturbance of the site context (e.g., rodent disturbance, dessication cracks, trampling [see Wood and Johnson 1978]). Destruction of perishable remains by weathering agencies removes a further portion of the archaeological record. Although these destructive physical and chemical agencies have substantially altered the HSI camp and processing site deposits, particularly the core area, the evaluation of spatial relationships in the peripheral campsite deposits is still plausible. This follows from the expectation of limited usage of peripheral areas, hence less disturbance, and the premise that some degree of disturbance can be tolerated in an analysis of patterning. Accepting the fact that all archaeological deposits are disturbed to a degree, it remains for the analyst to determine what level of resolution (i.e., grain size) is attainable given the disturbance factors in evidence.

It is largely inconsequential to an evaluation of generalized patterning that remains have moved horizontally and vertically since the time of deposition. The compact nature of the HSI substrate suggests that the degree of displacement has probably not exceeded the 50 cm^2 subquad and 10 cm level provenience recording scheme employed in the HSI block excavation. Artifact association remains a problem, however, for although two items are found in the same level and adjacent to one another, it is quite possible that they were deposited at distinctly different time periods. Unless these items can be demonstrated to be logically co-occurring phenomena, it would be incorrect to interpret their proximity as an association. It must be stressed that the deposition of residue materials on any surface over the course of many years will ultimately create a pattern of sorts. However, this pattern is a cumulative result representing many individual depositional episodes which may never be decipherable into discrete cultural events. The complex record of prehistoric activities represented by the HSI camp and processing site deposits can never be precisely broken down into discrete formation events. The best we can hope for is to determine with some accuracy what some of the more prolific activities may have been through a coarse level analysis, i.e., a generalized patterning of FBR and faunal remains.

Any activity that was conducted in association with a pit or hearth feature will tend to leave residues reflective of that activity within and in the immediate proximity of the feature. In other words, the distribution of remains in the immediate proximity of the feature has a higher probability of being associated with the use of that feature than remains found further away. Thus features act as a focal point of activity patterning, and a focal area for the deposition of specific activity refuse (Simek 1984:406). However, the presence of features alone does not guarantee that all prehistoric activities will be visible in the archaeological record. In most instances, the archaeological visibility of a given task will be directly proportional to the absolute size, quantity and durability of the residues resultant from that activity. For example, in the context of a partially disturbed deposit, it might prove less difficult to identify the residues associated with a meat roasting pit than to delineate a lithic reduction task associated with a hearth feature. In the case of the roasting pit, a particular suite of bone residues could be predicted, as well as a characteristic assemblage of FBR, both of which should appear in large quantities. The lithic reduction sequence may yield relatively few remains, and these might easily be obscured by subsequent activities or taphonomic processes.

Given that some kinds of tasks can rarely, if ever, be identified in a compressed deposit such as the HSI camp and processing site, only the most prominent faunal processing activities and feature associations should be considered. These involve the use of features and materials (e.g., FBR) in the processing of bison meat and by-products. Not all of these activities need necessarily be in evidence, for the block excavation represents only a tiny fraction of the site area. However, it does seem reasonable to predict that the more common and prolific activities of meat boiling, roasting and bone processing should be represented throughout the camp and processing site, and it is these upon which the pattern analysis is focussed.

The distributions of faunal remains and FBR are thought to possess substantive clues as to the range and parameters of secondary butchering activities conducted in the camp and processing site. For example, the distribution and structure of the FBR assemblage may help to determine which features were used for stone boiling (fine grained quartzite cobbles) as opposed to stone roasting (coarse grained sandstone slabs). The size of the FBR assemblage may vary depending on which of these two cooking technologies was employed. We assume that most of the small, thermally fractured cobbles found at HSI are the result of the rapid cooling stresses associated with stone boiling. The presence of thermally altered sandstone is thought to be indicative of other technologies including pit roasting and broiling which could be facilitated by the flat tabular structure of this local material. The distribution of non-sandstone and sandstone FBR may therefore help to delimit activity patterning in the same way that faunal distributions are felt to reflect aspects of discrete processing events.

The results of the faunal analysis presented earlier suggest that only selected portions of the bison carcass would have been transported from the kill to the processing site. Although this selection process is likely to have been governed by a number of factors (e.g., size of kill, herd composition, season, camp population, availability of resources, and settlement pattern scheduling), the variables of utmost importance were probably cultural preference for specific meat cuts (Binford 1978) and the nutritional value of the carcass portions (Speth 1983). The evidence for this selection process is manifest in the assemblage of bone recovered from the camp and processing site. By analysing the varieties of bone elements, the portions present, and their distribution, it may be possible to reconstruct some aspects of the activities conducted in the processing site. These activities may have included the roasting of prized portions of the bison carcass, such as the ribs and hump meat. The residues of such an activity would include rib fragments and portions of cervical and thoracic vertebrae (i.e., the boss ribs), in association with a cooking facility. In some cases, the meat portions may have been boiled rather than roasted (i.e., major meat joints of the fore and rear limb), leaving the residue of major limb bone portions. However, the identification of this type of processing is complicated by the potential for further modification of the boiled bone portions via marrow extraction and bone grease rendering.

When bone is processed for marrow, the breakage of the midshaft causes a reduction in the overall identifiable bone present in the site and removes evidence of previous processing (i.e., cut marks). When bone is processed for the extraction of embedded marrow and bone grease, the element is reduced further, usually to the point of unidentifiable bone fragments. This would obviously remove all evidence of previous processing and, therefore bone, processing must be envisioned as a single pathway which allows for the selection of several specific terminations. Thus, where the bone residues reveal largely whole elements found in a semi-articulated context, it is reasonable to infer that only the major muscle masses were removed. If the bone residues indicate that the larger limb bones (i.e., humerus, tibia, femur) have been split open, it is reasonable to infer that some marrow processing is indicated. Given the nutritional content and preferred food status of marrow, it is likely that cracking of some marrow bones (i.e., limbs) was almost always a corollary of processing the carcass. In exceptional circumstances, the bone marrow may have been depleted due to dietary deficiencies associated with the season of the kill (see Speth 1983), in which case there would be little point in conducting marrow processing. Late winter would have presented the most difficult of times for both bison and man, as the fall stores of fat and food would be rapidly dwindling. It has been recorded ethnographically that such times of stress can witness the scavenging of abandoned sites for elements that are well preserved and rich in grease (Wilson 1924). By crushing the articular portions of the major limb bones, and simmering these residues, it is possible to drive off the residual marrow and bone grease, thereby forestalling a depletion of minimal personal fat reserves. The consequence of such processing is the destruction of specific portions of the faunal record (i.e., grease bones) and the preservation of bone elements which have little nutritional value.

It is likely that all the aforementioned activities would have taken place within the block excavation at some point in the past, and in some cases, the complete sequence of meat removal, marrow extraction and grease rendering may have been undertaken. The latter two processing activities would likely have involved the use of hearth and pit facilities. In the analysis which follows, the distribution of FBR is examined to determine where the major stone boiling and stone roasting activities may have been undertaken. This is followed by the presentation of the faunal distributions which, when correlated with the FBR and feature distributions, help to delineate the boundaries of certain activity areas within the block excavation.

Methodological Considerations

Detecting spatial patterns in archaeological data distributions can be accomplished in either of two ways: visual inspection, or comparison with a mathematically modeled distribution. The distinction between the two approaches is clearly one of subjective (i.e., visual) versus objective (i.e., model) interpretation. Each approach has certain liabilities and assets where archaeological data are concerned. Mathematically modeled surfaces possess the advantage of being a "scientific" and replicable means of evaluating archaeological data distributions, but they do require certain assumptions to be made about the structure of the data itself (cf. Carr 1984:136-137). The validity of these assumptions can vary depending upon the simplicity or complexity of the archaeological deposits. For example, some mathematically derived models need to make assumptions regarding the shape and size of activity areas, the variety and numbers of tools employed, the spacing of activities and, most importantly, the period of time required for those deposits to form. These kinds of questions are extremely difficult to address when faced with the complex archaeological record of the HSI camp and processing site. A better approach, and the one adopted in this study, is to visually inspect the distribution of various remains and intuitively identify those areas of the site that exhibit concentrations of remains which can be interpreted as the logical result of specific prehistoric events. The major drawback of this approach is that visual perceptions vary markedly between individual analysts and the inferences drawn by individuals can be similarly at odds. In order to avoid overly fanciful interpretations, the activity identifications and speculations of prehistoric behavior patterning offered below are kept to a very generalized level. The archaeological record contained within the HSI camp and processing site negates monothetic interpretations, and requires that explanations be qualified as only "the most probable interpretation" (Thomas 1983:440), given the data at hand. Alternative explanations of spatial arrays of archaeological remains can never be discounted, for it is impossible to predict what may reside just outside the excavation boundaries, and these data may significantly alter the interpretation advanced regarding the exposed pattern of bone, FBR and features.

While it is true that large excavation units provide a better appreciation of the complexity and varieties of activities conducted on a living surface, they do not necessarily provide a more precise characterization of the activity patterning represented at the site. Therefore, while a 2 m^2 unit provides a larger "window" than a 1 m^2 unit, it does not necessarily explain more accurately the agencies that came together to form those deposits. Rather, it is the structure of the archaeological record which largely predetermines the validity of spatial analyses for, as Thomas has noted "... the quality of spatial information derived from a given living surface may be inversely proportional to the quantity of debris involved" (1983:438).

At HSI, we are not only confronted with massive quantities of remains from the living surface, but these remains are also superimposed and impossible to separate into stratigraphic sequence. We are nevertheless confident that our attempts to visually discern a pattern to this complex archaeological record are warranted, and that the 7x8 m block excavation provides an excellent "window" for identifying such patterning. Certainly, the excavation of an entire living surface would ensure that all archaeological residues would be taken into account when formulating explanations of prehistoric activity patterning, but to extensively excavate a complex ten hectare site is neither practicable nor consistent with reasonable archaeological practise. There is also no guarantee that such massive exposures would necessarily lead to a more precise definition of the activities being conducted in the camp and processing site.

An important consideration in the evaluation of spatial patterning of archaeological remains is to ensure that the size of the area analysed is sufficient to encompass the predicted size of the activity patterning being sought (Carr 1984:104). We assume that most of the processing activities conducted in the camp area were completed as a group activity, with the family serving as the basic unit of production. In some instances, such as bone grease processing, several family units may have been involved because of the intensive labour involved. However, despite the numbers of people involved, the activities themselves would have been restricted spatially to the hearth and pit complexes being utilized. This suggests that, although the area in general association with the activity may have been large (i.e., dozens of square metres), the focus of the processing activity (i.e., the hearth, pit and processed materials) is likely to have involved a much smaller area. This in turn suggests that the concentrated residues from such processing activities are likely to be confined within a small focal area. In this analysis, we make the assumption that the minimum focal area of a discrete processing event is probably restricted to a zone which can be accessed from a seated position (i.e., one metre radius). On the basis of this assumption, it is requisite that pattern evaluation be conducted using similar or larger scale resolution in order to discern patterning. This is essentially a methodological problem associated with mapping spatial data, and a review of relevant issues is presented below.

Mapped distributions of archaeological remains, or any maps for that matter, are simply symbolic representations of a spatial structure (Harvey 1969:376). The map is not necessarily an accurate depiction or an empirically realistic portrayal of the data under scrutiny; it is up to the analyst interpreting the map to demonstrate its validity. One of the prime considerations in demonstrating the validity of maps is the justification of the data manipulations that are requisite in order to produce those maps. These manipulations are among the first steps in the creation of the mapped information and involve determination of the map size, the size of the grid matrix, the search algorithm employed, range and interval of scale selected and the perspective of the map (i.e., two or three dimensional). The selection of these various parameters obviously predetermines the ultimate configuration of the map, and varying these elements can lead to different interpretations of the same data distributions. Jermann and Dunnell (1979) provide an overview of the methodological issues involved in the assembly and interpretation of isopleth maps, and some of these are applicable to HSI.

Although all of the HSI data were collected at the minimum provenience of a 50 cm^2 unit, all of the mapped data are calculated on the basis of a 1 m^2 grid. The choice of the 1 m^2 grid was predicated on the expected minimum size of activity loci and the comparative evaluation of the data distributions using 50 cm^2 and 1 m^2 grid sizes. The 50 cm^2 grid provides 224 reference points over a 7x8 m surface distribution, as opposed to 56 nodes when a 1 m^2 grid is employed. Despite the fact that a 224 position grid provides greater resolution of detail (cf. Little 1985), it does not necessarily provide a clearer or more accurate representation of the data distribution. If the assumption of a 1 m^2 minimum activity dispersion is accurate, the subdivision of such a distribution would likely inhibit rather than promote pattern recognition. Thus, there is a very real potential for the introduction of noise into a data distribution by enforcing too fine a grid matrix on spatial distributions.

Prior to the analysis, a variety of working maps were produced using 50 cm^2 (n=224), 1 m^2 (n=56) and 2 m^2 (n=16) grid sizes. It was evident that the 1 m^2 grid provided the best results, for it appeared to preserve the basic qualities of the detailed 224 node grid while avoiding the over simplified perspective offered by the 2 m^2 grid. Other parameters of the mapping package were altered to compare and contrast their effects on the map structure. These included the map size, the scaling interval chosen, density of isolines and the arrangement of the grid nodes. All of the maps were run under the

Surface 2 Computer Software system (Sampson 1978) and output on a Calcomp Plotter.

One of the many mapping questions we needed to address was how the shape of the mapped data was influenced by the structure of the grid (i.e., data point locations). The mapping programme requires that counts of items be assigned a coordinate location (node), despite the fact that they are continuously distributed in the archaeological context. Thus, the centre of each grid node (1 m^2) was assigned a value (e.g., count of FBR, count of faunal elements) which was then used in comparison to its neighbouring nodes to produce a continuous surface distribution. Because of the complexity of the data distributions within the block excavation, it was determined that a "local fit" grid procedure would be most appropriate "... based on the intuitively appealing idea that a nearby observation is a better estimate of the value of a point on a surface than a more distant one ..." (Sampson 1978:8).

The local fit procedure takes place in two stages; the first stage uses a nearest neighbour distance weighted function to project a surface over the 56 grid nodes. In the second stage, a value is assigned to the grid nodes based upon a nearest neighbour search and distance weighted averages of values around the nodes. Because the HSI data are continuously distributed, the first stage of the grid procedure is unnecessary. This leads to the speculation that the shape of the mapped distributions may in fact have more to do with the layout of the grid rather than any actual structure in the data distribution. We therefore experimented with a regular and irregular grid layout using identical sample data to ascertain the extent of these shape effects.

Figure 89 presents three map distributions, all of which are based on the same data but calculated in a slightly different way. The two smaller maps were both assembled using a regular one metre square grid, but differ in the contour interval, isoline shading, and value ranges being projected. The large map (Figure 89c) is based on an irregular grid and employs different shading, value ranges and intervals. This irregular grid is not the equivalent of a randomly sampled series of data points, but does represent a departure from the regular 56 node grid. In comparing the small maps (Figure 89a and b) with the large map, it is evident that more regular, almost squarish concentrations of isolines are

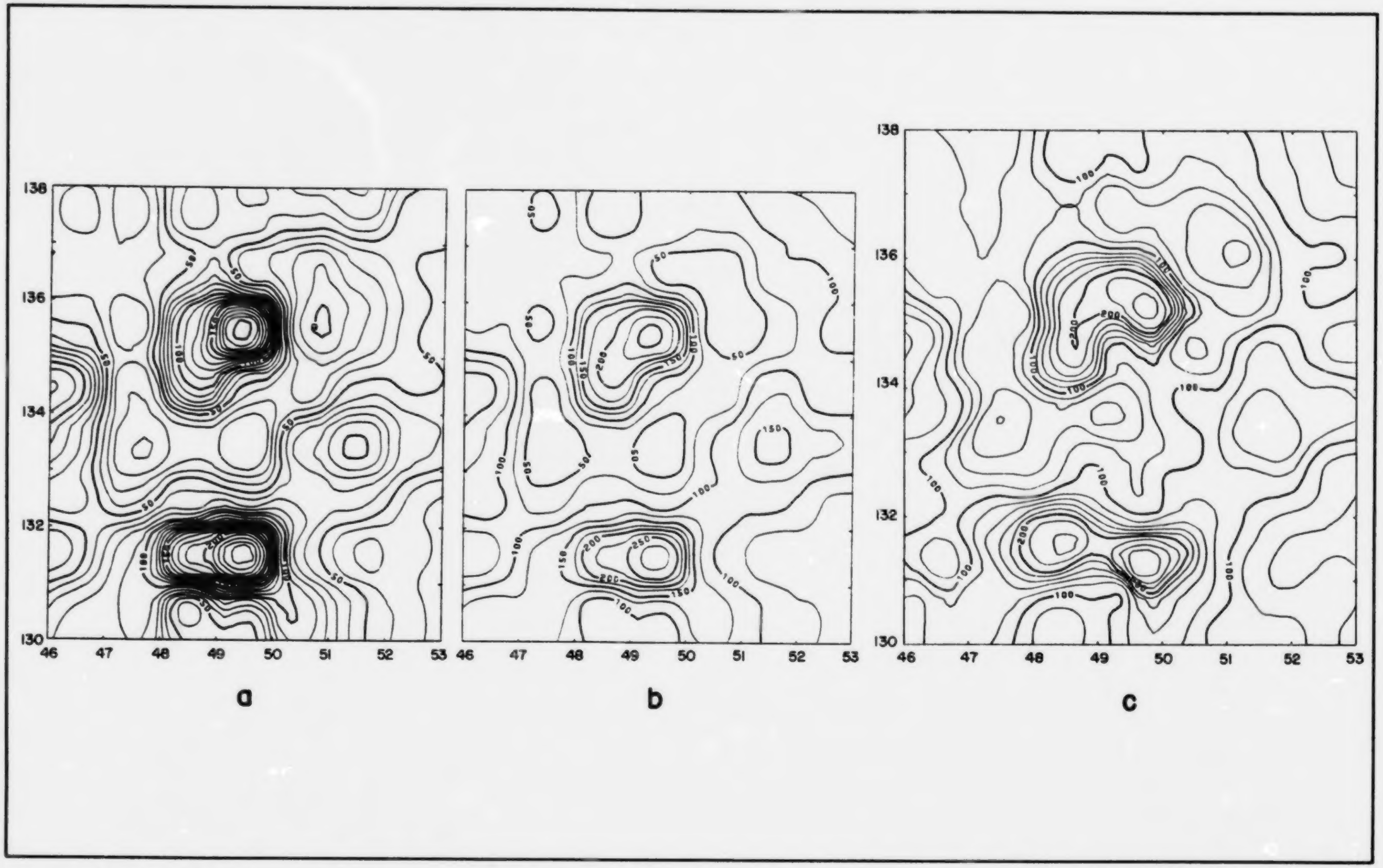

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Figure 89. Comparison of various mapping parameters and their visual effect using identical data.

the result of the regular grid. This uniformity is not present in the larger map and the concentrations of data values, although remaining in the same general location, have undergone a change in shape. These shape effects are not considered important in that the basin concentrations are accurately portrayed in all maps, albeit with more emphasis when using a smaller map and greater number of isolines (Figure 89a).

Obviously, all map distributions represent a compromise between accurate portrayal of the empirical data distribution and the analyst's need to convey certain bits of information contained within that distribution. It is a tried and true maxim that the longer you look for patterning in a distribution the more likely you are to discover patterning. The analysis which follows is no doubt guilty in some respects of interpreting too much from too few remains dispersed over too small an area. However, in each case the identification of a pattern, or concentration of remains, is only advanced in the presence of supportive evidence based upon other (i.e., non-distributional) information.

Fire Broken Rock

The pattern analysis of the FBR recovered from the block excavation addressed a number of research questions. It was evident that the overwhelming proportion of the FBR assemblage was made up of non-local source materials, with only minimal use of the local sandstone rock. We therefore questioned whether the sandstone was only being used for specific tasks, and not as general boiling stone material. This might be partly reflected in the restricted distribution of this material type. Perhaps the sandstone was only used in association with dry roasting or broiling of foodstuffs and, therefore, should not occur in proximity to boiling pit features.

The obvious preference for non-local source materials as boiling stones suggests that such items would be extensively recycled prior to final discard (see FBR analysis, this chapter). When evaluating the distribution of the non-local materials, it might be possible to identify evidence of discard versus stockpiling based on the average size of fragments recovered from specific areas of the block excavation. That is, given the immense amount of human labour which must have been expended to haul quartzite and limestone cobbles from 1 to 2 km away, we would expect this material to be heavily curated, reused and cached much more than one might expect at sites where preferred boiling stones are immediately available. Furthermore, this intensive reuse of the imported stone material will promote greater fragmentation and result in small sized fragments being discarded only when they are no longer usable. These stockpiles and discard areas may be associated with individual pit features and processing activities. To facilitate the identification of these concentrations, the provenience data on FBR was converted to counts and weights by material type and size category for each 1 m^2 within the block excavation (n=56).

Three varieties of maps are employed in the analysis of FBR distributions: grid node plots, isopleth maps and perspective block diagrams. The grid node plots and isopleth maps provide a rapid means of assessing the relationship between the actual distribution of the data values and the interpolated distribution offered by the mapping algorithm (Figures 90 and 91). The perspective block diagrams are particularly useful for they impart a third dimension to the data distribution and represent the actual data values at their location as compared with the interpolated surface of isopleth projections. The orientation of the perspective block diagram is always the same; that is, the lower right corner is always the southeast corner of the block excavation unit. The height of the peaks and depth of the troughs over the undulating surface provide a direct measure of the count and size of FBR at that location within the excavation unit, albeit exaggerated in vertical perspective.

The first step in assessing the FBR distribution involved consideration of the two material types, non-sandstone and sandstone. It was previously established that non-sandstone was numerically superior to sandstone FBR in a ratio of approximately 6:1. The impression gathered from inspection of the field drawn floor plans of FBR was that of a relatively uniform and patternless distribution of stone across the excavation unit. However, when the actual counts of FBR were summarized by 50 cm^2 and 1 m^2 provenience, it became apparent that some areas contained abundant FBR and that these concentrations were spatially discrete. Apparently, there was either too much information in the hand drawn plots to allow for a visual detection of these concentrations, or

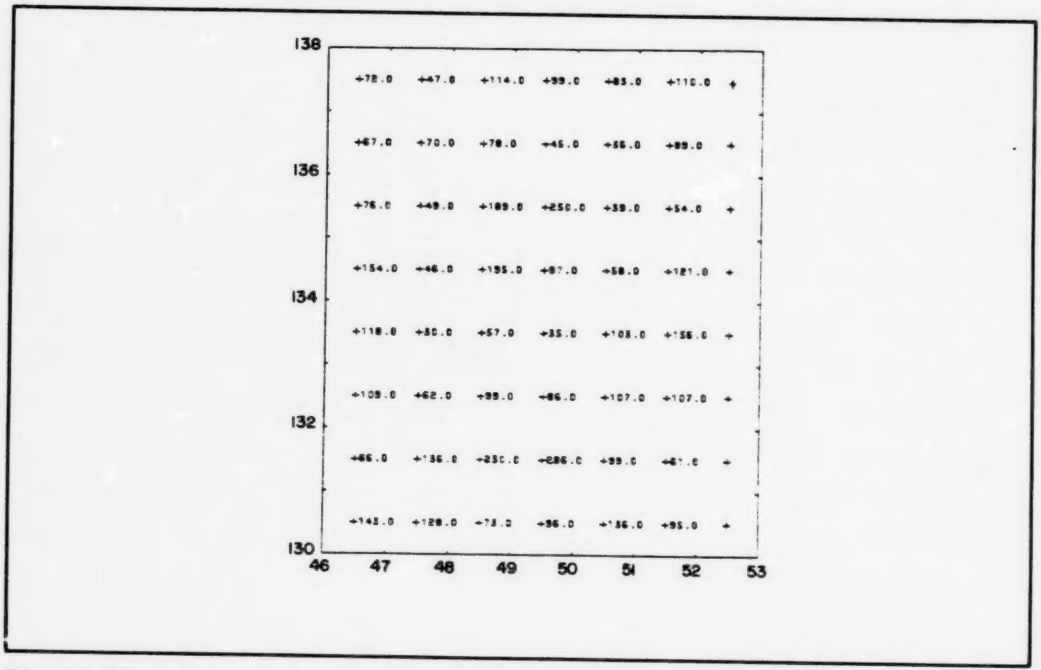

Figure 90. Grid node plot of non-sandstone FBR (count per one metre square).

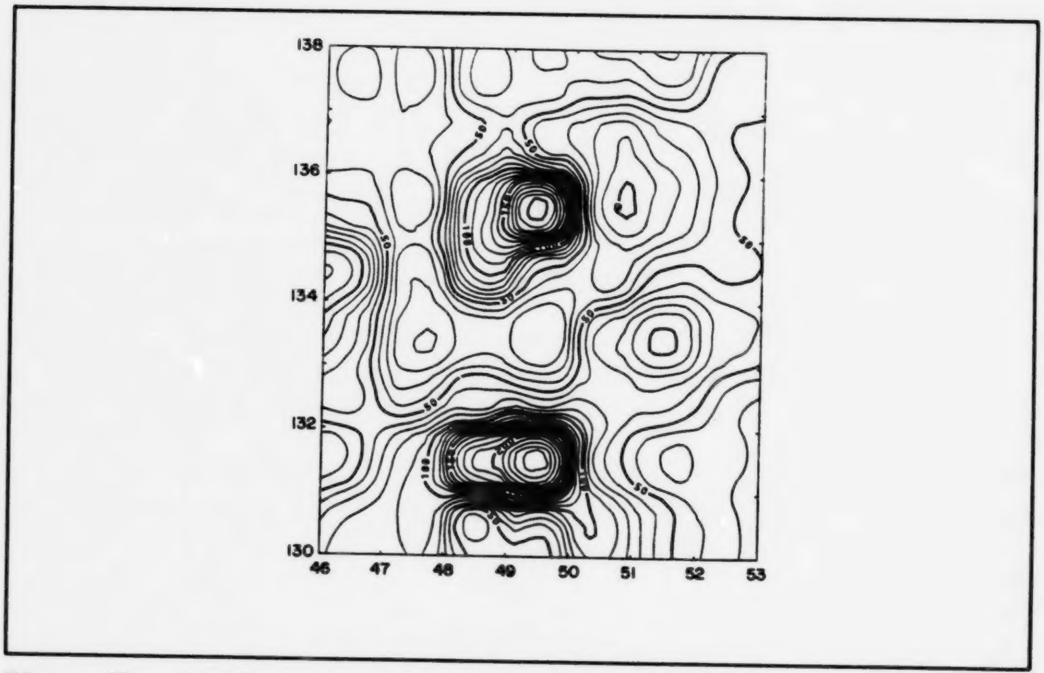
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Figure 91. Isopleth map of non-sandstone FBR (count per one metre square).

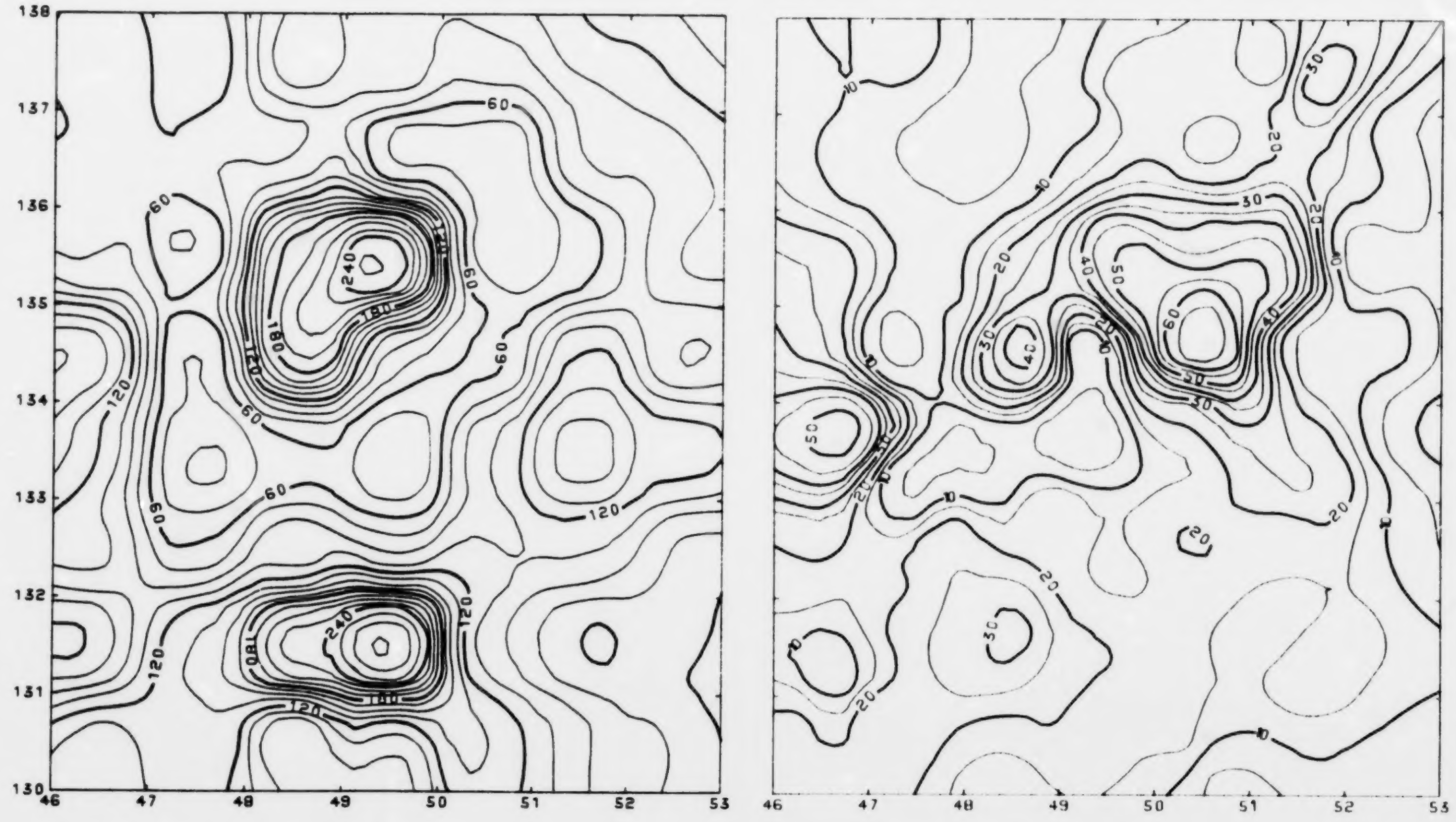
inconsistencies between excavators' depictions of the floor plans served to mask the actual distributions.

Isopleth plots of non-sandstone and sandstone FBR are presented in Figure 92 and the projections are remarkably different. The non-sandstone distribution reveals two prominent concentrations with densities in excess of 240 items per one metre square. The larger of the concentrations is located in the northern half of the block excavation. Although the southern concentration covers a smaller area, the density of FBR is greater, with in excess of 280 items per square metre. Other zones within the unit reveal closely spaced isolines, but none is sufficient for purposes of identifying discrete concentrations.

The distribution of sandstone does not coincide with the non-sandstone concentrations, but does reveal three clusters forming a southwest/northeast band across the unit. These concentrations of FBR are more clearly revealed in the perspective block diagrams presented in Figure 93. When comparing the isopleth plots (Figure 92), it is important to note that the contour interval is much smaller for sandstone FBR and that the absolute density of sandstone rarely exceeds 30 items per one metre square. In fact, most of the block excavation is characterized by a density of between 10 to 16 items of sandstone FBR per m^2 (Figure 92).

Previous analyses of FBR size categories revealed that the sandstone and non-sandstone assemblages were proportioned similarly (see Figure 65). That is, most pieces of FBR were 5 cm or less in maximum dimension, and approximately 40% of both assemblages falls within the 5-10 cm size category. No attempt was made to map the size characteristics of the sandstone assemblage, as the counts for any given 1 m^2 were simply too low to allow for meaningful comparisons (i.e., less than 15 items). Arguments presented earlier noted that the size of the sandstone FBR assemblage is most likely the result of post-depositional fracture through trampling, and may have no significance for reconstructing cultural behaviors.

The non-sandstone FBR assemblage is, on the other hand, much less susceptible to such post-depositional fracture and is sufficiently abundant to warrant comparisons. Only the 0-5 and 5-10 cm size classes are plotted; the assemblage above 10 cm in size contains but 61 items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Contour Interval = 15 items
n = 5617

Contour Interval = 5 items
n = 994

Figure 92. Isopleth maps of sandstone (right) and non-sandstone (left) FBR distribution.

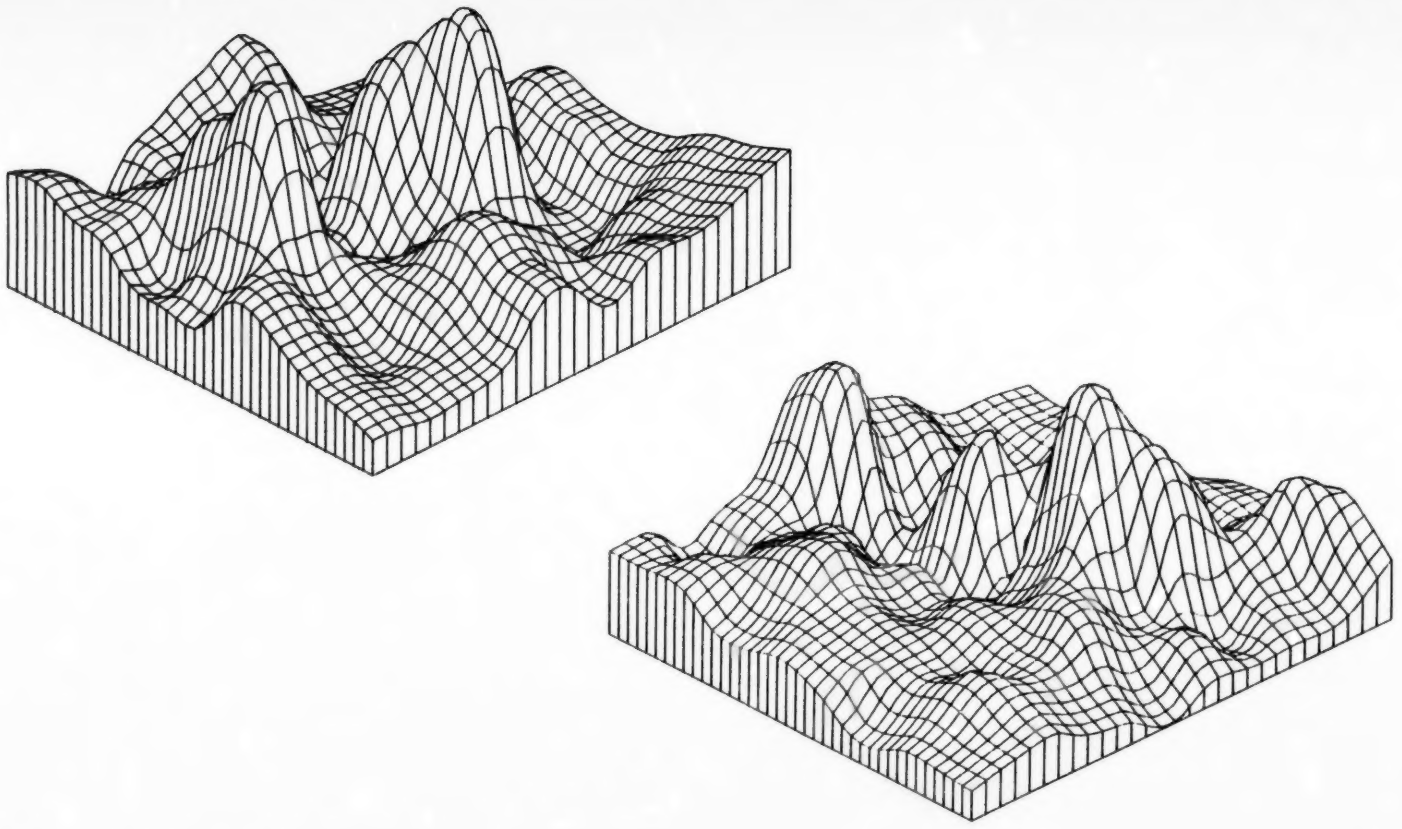


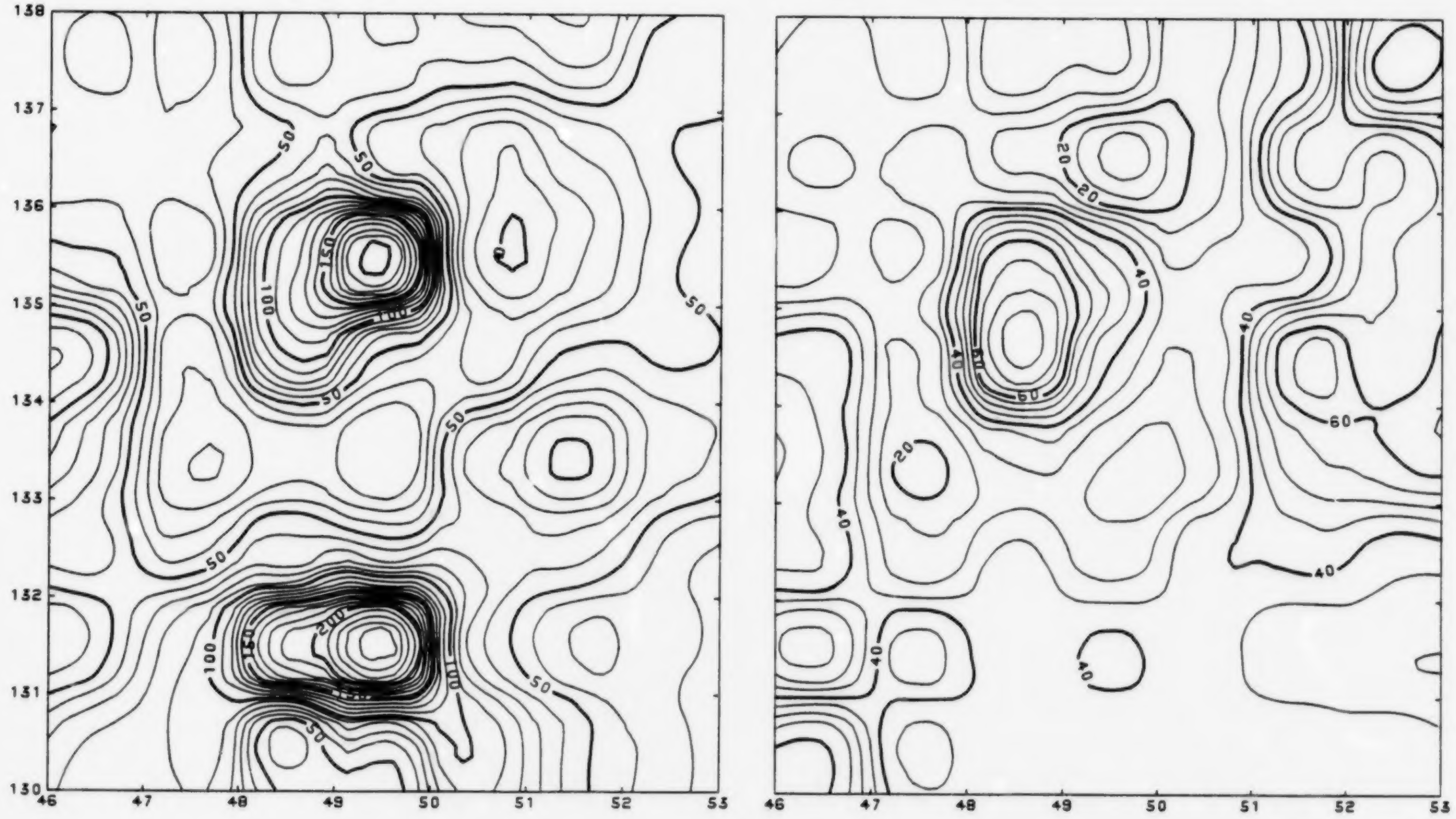
Figure 93. Perspective block plots of sandstone (lower) and non-sandstone (upper) FBR distributions.

representing only 1.1 % of the assemblage. The size classes are presented in isopleth maps (Figure 94) and perspective block diagrams (Figure 95).

The 5 cm size class reflects the two concentrations recognized in the material type maps and illustrates once again that the southern concentration contains the greatest density of FBR. However, when we compare the distribution of 5-10 cm sized FBR, there is a marked departure from the former pattern. The northern concentration remains intact, although the centre of the cluster has shifted to the southwest (Figure 94). The southern concentration has almost totally disappeared and other less pronounced concentrations are now evident in the extreme southwest and northeastern sectors of the unit. The disappearance of the southern cluster dramatically illustrates that the FBR in this concentration is smaller than that in the north half of the unit, suggesting that the increased density of FBR fragments in this area may represent a discard pile of exhausted FBR (Table 28). This presupposes that fragments less than or equal to 5 cm in size are too small to be efficiently recycled and that those fragments larger than 5 cm are reusable. This supposition is supported by the experimental observations recorded during the course of some replicative studies (see Chapter 5). Based on this assumption and the threefold increase of larger sized pieces of FBR recovered from the northern concentration, it is tentatively advanced that this northern concentration represents an

Table 28. Comparison of FBR fragment size and density in the block excavation.

		Size		
		0-5 cm	5-10 cm	Total
Southern Concentration	n	437	77	514
	Wgt.(kg)	5.0	9.6	14.6
	[avg. wgt.]	[.011]	[0.13]	
	Density/m^2	218.5	38.5	
Northern Concentration	n	416	186	602
	Wgt.(kg)	8.3	44.1	52.4
	[avg. wgt.]	[.020]	[0.24]	
	Density/m^2	138.6	62.0	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Contour Interval = 10 items
n = 4013 Size = 0-5 cm

Contour Interval = 5 items
n = 2522 Size = 5-10 cm

Figure 94. Isopleth maps of non-sandstone FBR distribution based on size characteristics.

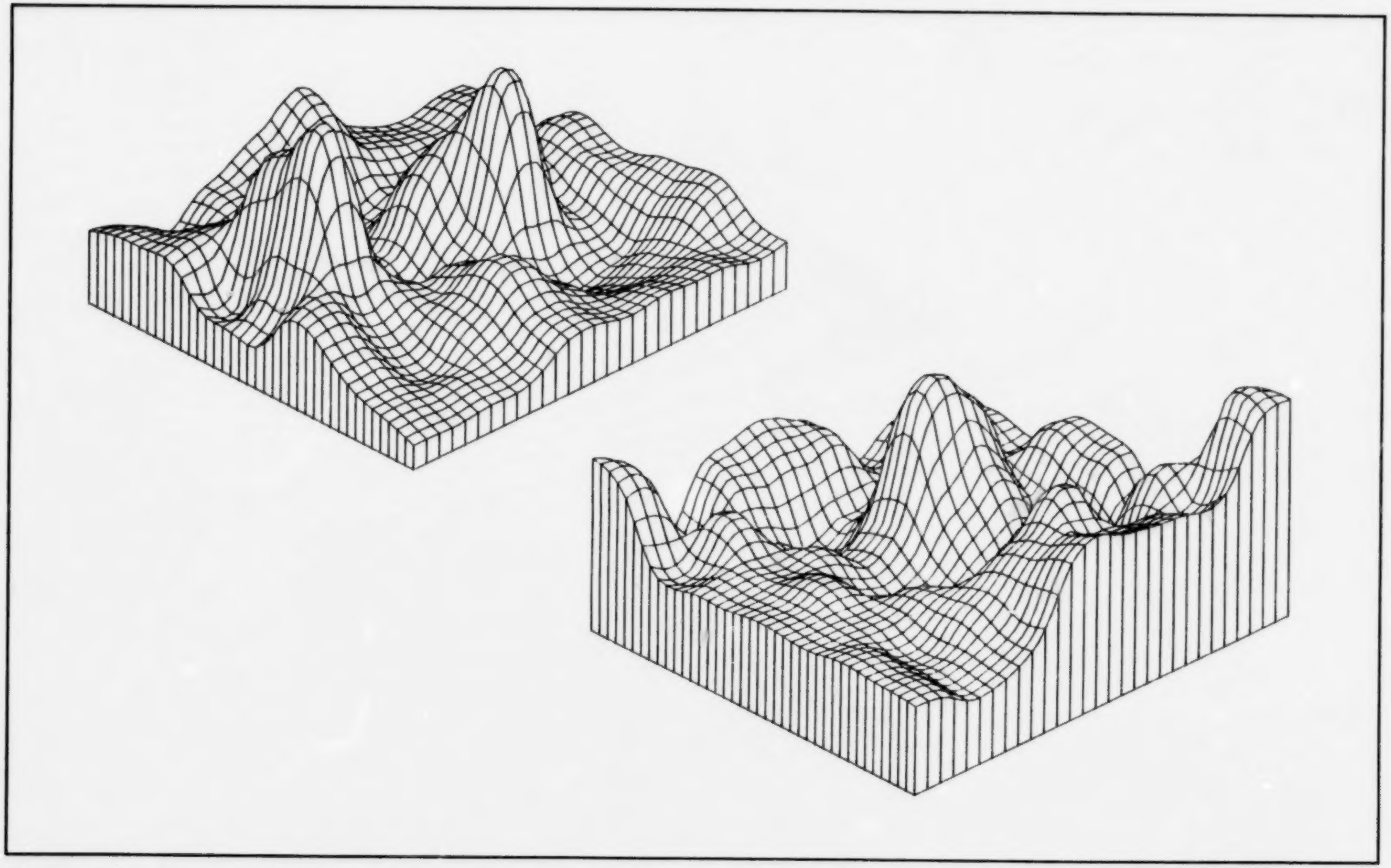

Figure 95. Perspective block plots of non-sandstone FBR based on size (upper 0-5 cm, lower 5-10 cm).

assemblage of primarily reusable FBR. Other lines of evidence such as artifact and feature distributions can be brought forward to support an argument for such activity patterning.

The presence of a partial tipi ring feature in the northern half of the block excavation (see Figure 12) suggests that a structure may once have existed here, and that the pile of FBR would thus be within the structure and the discarded cluster outside the structure. Additional lines of evidence in the form of hearth distributions, pit locations and bone upright features discussed earlier support the case for the presence of a structure in the north half of the unit (see discussion of features, this chapter).

The argument in favour of curated stockpiles of FBR is not based solely on the size of the fragments, although this is an essential attribute to be considered when distinguishing between discard and recycling activities. It seems most reasonable that a size threshold exists at which FBR is no longer recycled and that this critical size is contingent on a variety of site specific factors such as distance to raw material source areas, type of activity associated with FBR use (i.e., stone boiling, stone roasting, hearth lining), and manpower available. Given these factors, it is likely that the discard threshold will be different for every site, and this may even vary within the same site given different seasons of occupation and activities undertaken. For example, we assume that some of the FBR at HSI may be the result of stone boiling associated with bone degreasing, but it is unlikely that the occupants of HSI would always conduct bone degreasing after a successful hunt, owing to factors of animal condition, abundance of the kill, available manpower and season of the kill. The few examples of recorded ethnographic accounts of stone boiling are of some help in this regard, particularly with respect to the amount of time and manpower that is requisite when using stone boiling technology. Binford characterizes stone boiling technology as a, "... labour intensive activity; requiring great amounts of firewood, patience and labour... ", and that he was, "... overwhelmed by the sheer activity levels that had to be maintained to process large quantities of bone successfully" (Binford 1978:158-159). Binford recorded the material requirements of these latter activities and noted that 32 river cobbles weighing an average of

.9 kg were gathered for purposes of stone boiling. Another assemblage of 938 stones weighing an average of .7 kg each is thought to represent a discard assemblage of stone from a single episode of bone degreasing which may have employed boiling stone technology (Binford 1978:159). The small difference in average weight of the two assemblages cannot be assumed to be indicative of a critical size threshold where the stone could no longer be recycled efficiently.

In some instances, the average stone weight recorded by Binford equates quite closely with the average weight of FBR recovered from some of the HSI pit features. We would assume that the FBR within the pits is more likely to be in a recycling sequence than the FBR which is found in non-pit contexts and is therefore likely to represent discard. Returning to Table 28, we find that the average weight of the FBR fragments in the north and south clusters demonstrates the larger size of the north cluster. If it is assumed that the larger sized pieces in the northern cluster are in a recycling context, then the critical threshold of discard may occur when the average weight of each fragment drops below 0.1 kg. The relationship of fragmentation, average weight and discard size is modeled in Figure 96.

In order to evaluate the usefulness of such a model, the FBR data from features was plotted in comparison to that derived from non-feature contexts. Not surprisingly, the feature data were seen to fall within the recycled zone (greater than 0.1 kg), while the non-feature data resided in the discard zone (less than 0.1 kg). The value of this graphic relationship is purely descriptive; it has no predictive potential and certainly could not be applied outside the HSI site setting. Although the discard threshold is demarcated by a straight line (Figure 96), it is unlikely that such a construct could be validated with empirical observations, given the number and variety of uncontrolled variables at hand. The figure is, nevertheless, useful as a visual projection of how FBR assemblages can be viewed as a component of the overall site assemblage. In the case of HSI, it is evident that a good deal of effort was expended in the gathering and transport of these non-local resources. This, no doubt, encouraged maximum use of the raw material which, in turn, produced an FBR residue assemblage that is smaller than that which might be expected when local resources are abundant.

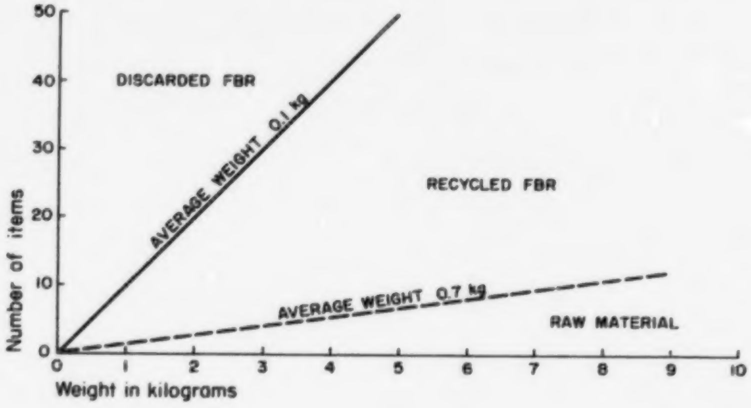

Figure 96. Modeling the relationship between recyclable and discarded FBR assemblages.

The analysis of the distribution of FBR residues was directed at the discovery of associations between features and discrete concentrations of FBR. Although the analysis successfully demonstrated that the distribution of FBR is far from uniform over the floor of the block excavation, it was not possible to identify any specific feature associations. This is probably the consequence of several factors, including the masking effect of the superimposed residues from multiple occupations, the dispersion of discrete concentrations through trampling, bioturbation and resource recycling. Although concentrations of FBR were defined and their characteristics discriminated, they simply cover too large an area to allow feature associations to be determined. It seems most likely that a combination of discrete activities have created the anomalies identified in the FBR distribution. At present, there does not appear to be a ready explanation of why the concentrations in the block excavation should be structured so differently, although the presence of the tipi ring structure has been advanced as one interpretive approach. The study results underline the importance of searching artifact distributions for patterning despite the overwhelming evidence for superimposition, trampling and post-depositional disturbance. It is evident that some patterning is indicated by the distribution of FBR pieces even though confident explanations are not at hand. The analysis of faunal distribution which follows was somewhat more successful in the identification of discrete activity area residues and feature patterning.

Faunal Distribution

Although several species of mammal were recorded within the block excavation, only one was sufficiently well represented to permit an evaluation of patterned distributions of bone elements. The remains of bison (Bison bison) accounted for 98.5% of the faunal assemblage, representing over 3000 elements and element portions. The analysis of faunal remains from pit features suggested that the presence of particular suites of faunal remains (i.e., repetitive arrangements of elements and element portions) may be representative of discrete processing events (i.e., meat stripping, meat roasting, meat boiling, marrow and bone grease processing). The purpose of this section is to draw together some of the functional hypotheses advanced in the analysis of feature assemblages and to compare these with the distribution of bison bone residues from non-pit contexts. It was hoped that such comparisons would both support the previously advanced propositions and help to clarify our understanding of bison processing activities at HSI.

Faunal remains are, in some respects, better suited to the analysis of patterned distributions than other artifact classes. This follows from the belief that analytic categories for fauna can be derived more objectively than the arbitrary and subjective classifications characteristic of other archaeological data. Although it is difficult to accurately reconstruct the prehistoric butchering sequence and establish cultural preferences for certain cuts of meat, the faunal remains found in archaeological deposits do provide some clues. For example, Binford (1978) and Speth (1983) suggest that decisions regarding the selection of carcasses and carcass portions, and the decision to process non-meat components of the carcass are often manifest in the faunal record. Therefore, if specific meat selection and carcass processing activities were undertaken, there should be a corresponding assemblage of bone residues which mirror those activities. The analysis of faunal distributions which follows investigates the distribution of particular bone element sets and element portions that would be expected to occur as the result of specific processing activities.

The methodology employed in the assessment of faunal distributions is basically similar to that employed in the analysis of FBR, with some notable exceptions. Unlike other artifact classes, it is possible to quantify the numbers of bones at a site in a variety of ways. Each of these quantification schemes is thought to reflect different aspects of the assemblage but NISP (Number of Identified Specimens) is thought to provide the best available ordinal measure of abundance (Grayson 1984:92). Most of the map distributions which follow are based on NISP counts, but some elements such as cranial fragments and rib portions are actually based on a different measure. Crania and ribs are highly susceptible to post-depositional fracture, and an NISP count would result in an incorrect impression of element abundance (cf. Table 26). This taphonomic factor can be ameliorated by adopting alternative means of quantifying faunal remains such as calculating the Actual Number of Individuals (ANI), Corrected Number of Specimens (CSI) or Weighted Abundance of Elements (WAE). The derivation of these measures is far from straight forward (see Lyman 1982:359-363) and, at HSI, we opted for counting multiple fragments of a single bone as a single NISP when it was apparent that the in situ remains were derived from one fragmented element.

Comparison of feature locations and bone residues is facilitated by plotting some, but not all, of the pit features on the bone distribution maps. For example, bone uprights are not plotted, as their association with respect to meat and bone processing remains unclear, whereas boiling and roasting pits can be expected to have been actively involved in such processing activities. The features which are plotted all possess C-14 dating estimates which fall within the last 1000 radiocarbon years (see Table 2).

A total of eight bone distribution maps are evaluated. The first simply presents the distribution of all bison bone within the block excavation. This is followed by four maps which focus on specific portions of the bison carcass, as represented by cranial, axial, rib and appendicular bone elements. The final three maps are concerned with the evaluation of specific bone processing activities, including bone marrow extraction and bone grease rendering.

Figure 97 presents two maps which illustrate the distribution of all identifiable bison bone elements and appendicular remains within the block excavation. An obvious relationship exists between the location of pit features and the distribution of identifiable bone elements. This is to be expected, for the plots are both a reflection of the bone which occurs within the pit, as well as that which occurs in the immediate vicinity of that pit. The preservation of faunal specimens is greatly improved by burial within pit matrices, and it is, therefore, reasonable to expect a reduced survivorship of bone in non-pit contexts. The implication of this taphonomic reduction is that the distribution plot of bone is primarily a reflection of the bone found within the pit and, less the bone found in the "activity area" which is presumed to have surrounded the pit. For example, a large pit feature along the eastern edge of the block excavation unit contained an impressive assemblage of identifiable bison bone (NISP=134, see Figures 49-51) which results in a closely spaced series of isolines. If the pit contents were solely responsible for the concentration of isolines, it would be expected that the centre of the distribution and the centre of the pit should more or less coincide. However, this is not the case; the heaviest distribution is, in fact, located to the southwest of the pit, indicating that significant concentrations of bone must occur within these adjacent mapping units. This is indeed the case, with NISP counts of 41 and 34 elements in the adjacent units, as compared with an average count of 24 elements for the entire block unit (NISP=1331, by 56 mapping nodes). Therefore, the supposition that activity areas would occur in the vicinity of pits appears to be supported by the overall distribution of bison bone elements. More specific aspects of activity patterning can only be discerned by selective scrutiny of portions of the faunal assemblage, particularly those bone elements which are thought to be indicative of distinct processing events.

The second plot evaluated is that of appendicular bone (Figure 97). It is not surprising that much of the structure of this distribution is identical to that seen in the overall bone plot and that the appendicular bone is basically concentrated around four pit features. The activities

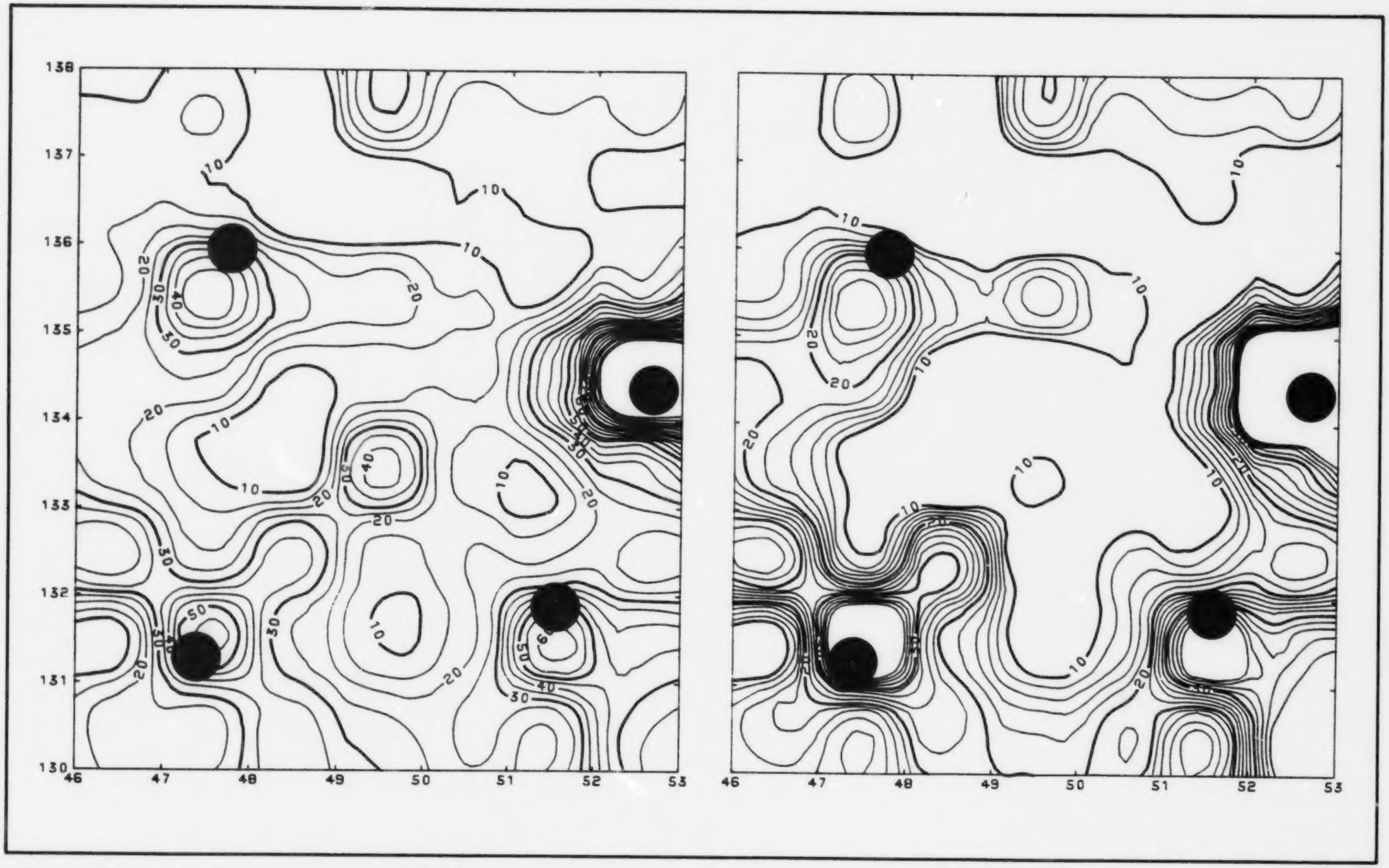
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Figure 97. Isopleth maps of bison bone distributions in the block excavation (left plot - all bone; right plot - appendicular bone).

conducted in the camp and processing area obviously focussed on the processing of appendicular remains, but some interesting observations are forthcoming when this distribution is compared to the plots of cranial, axial and rib bone. Bones from the cranium are found throughout the block excavation and, although some concentrations are evident, the magnitude of the isolines hardly warrants detailed interpretation (Figure 98). We would expect very few crania in the camp and processing area, given the low utility of this particular portion of the carcass. The fact that some crania do occur in the block excavation may indicate the removal of brains for food or tanning and the removal of horn cores (Verbicky-Todd 1984).

The distribution of rib and axial elements provides some evidence for isolated activity sets in association with pit features. In the case of rib portions, there is a single concentration associated with the pit located along the east margin of the block excavation (Figure 98c). A similar concentration is also evident in the plot of axial elements (Figure 98b), suggesting that both ribs and vertebrae were processed in or near this pit. The ethnographic record documents that ribs were a particularly favoured cut, and that they were often roasted rather than boiled. It is similarly recorded that the vertebral projections of the cervical and thoracic vertebrae known as the "boss ribs" were also preferred cuts for roasting (Verbicky-Todd 1984). It is not surprising to find, therefore, that the vast majority of axial elements associated with this feature are cervical and thoracic element portions. There is another concentration of axial remains in the northwest quadrant of the block excavation (Figure 98b), and these too proved to be primarily cervical and thoracic elements. The composition of these faunal assemblages and their proximity to features suggest that some discrete processing has gone on in these two areas of the block excavation.

These remains are representative of only a small portion of the bone elements recovered in each of these areas; however, their significance resides not in the NISP count but rather in the spatial isolation of the activities. It is difficult to explain this anomalous distribution in the absence of cultural behavior patterning; certainly no taphonomic agent can be offered as a probable cause of such patterning. We therefore suggest that broiling or roasting of rib sections, including vertebral spines (boss ribs), were some of the activities conducted in

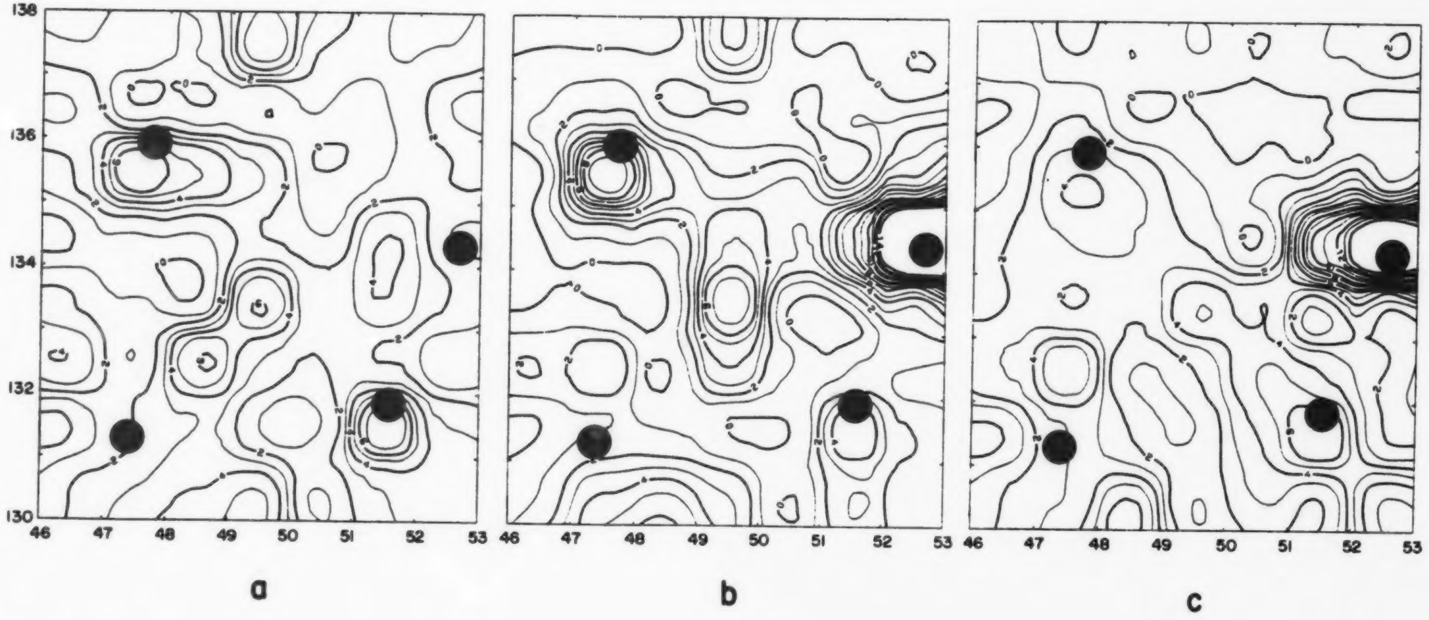
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Figure 98. Isopleth maps of bison cranial (a), axial (b), and rib (c) bone distributions in the block excavation.

association with the two northernmost features in the block excavation. The consumption of resources, while an important part of the processing site activities, represents only one aspect of the conversion of resources into foodstuffs. Preservation of the kill's bounty was an important aspect of processing and one that was essential in order to forestall future shortages in resource availability.

The activities associated with the preservation of foodstuffs are not always manifest in the archaeological record. Meat stripping and drying were no doubt integral means of preserving food at HSI, yet there is no obvious archaeological evidence of this important activity. Pemmican manufacture can be inferred from the presence of tools that may have been employed to pulverize the meat, but these kinds of tools can be employed for a variety of other tasks not related to pemmican making. While direct evidence for preservation of bison by-products is scant, a variety of indirect indicators are available in the archaeological record. For example, it has been tacitly assumed that the substantial volumes of fragmentary bone and FBR at evidence in HSI and other kill complexes is partly the result of bone processing for marrow and grease extraction. The bison, like most large land mammals, maintains most of its fat reserves in the form of subcutaneous tissues; however, these types of fat may not have been considered the equivalent of the lipids (fats) available in bone marrow and bone grease. Evidence from ethnohistoric, ethnoarchaeological and ethnographic documents clearly indicates that marrow and bone grease were prized both as delicacies and as a nutritious supply of essential carbohydrates (Binford 1978; Speth and Spielmann 1983; Verbicky-Todd 1984). Although it is impossible to verify whether prehistoric groups held the same opinion as to the preferred taste and nutrition of marrow/grease, we have no reason to believe that such a preference did not exist. Grease was an essential ingredient in the manufacture of pemmican, for dried raw meat is insufficient on its own to sustain a healthy balance of protein and carbohydrate intake. Assuming that the physiological makeup of prehistoric populations did not differ markedly from historic groups, and accepting the view that subcutaneous fat was inappropriate for pemmican manufacture, leads to the unavoidable conclusion that some marrow and grease processing must have been conducted at HSI. The questions to be resolved are what proportions of the processing activities were devoted to these tasks, and how would these tasks manifest themselves in the archaeological record.

Evidence from historic and ethnographic accounts, ethnoarchaeological studies and experimental replications all assist in the investigation and identification of bone processing activities. Assuming that ethnohistoric documents and ethnographic observations are accurate reflections of both prehistoric subsistence practices and cultural preferences allows us to identify a select subset of the bison appendicular skeleton which would have been processed for grease and marrow. The bone elements and element portions which are thought to be indicative of bone processing were formerly discussed in the analysis of faunal remains and are briefly summarized below. The elements evaluated include only the major limb bones and, while Binford's indices for grease and marrow were considered (Binford 1978), they have not been adopted in toto. Bone density is an important consideration in bone processing (cf. Lyman 1984), and observations resulting from a series of bison bone processing experiments have assisted in determining which bone residues we feel would be indicative of discrete bone processing tasks. Included in this discussion is an overview of the other material requirements of bone processing, such as fuels, stone and FBR supplies.

The extraction of marrow plugs from the major limb bones requires few, if any, tools if the marrow is consumed raw. Archaeological residues of such an activity would include the articular ends of the bone, which should exhibit impact fractures and fresh (green) bone breaks (Figure 99). Further processing for the extraction of embedded marrow and grease would focus on a specific subset of the articular ends noted above, specifically, those bones that are large, contain a high proportion of grease and can be readily reduced to small fragments thus maximizing grease retrieval. This activity has many requirements, including tools to fracture the hard articular ends, material supplies of fuel, FBR and facilities such as hearths and boiling pits. It is a commonly held opinion among those who have witnessed or attempted to replicate bone degreasing activities that never was so much invested for so minimal a return (cf. Binford 1978). The volumes of bone, stone and fuel which are consumed in the process of obtaining bone grease surely made it one of the most costly resources associated with bison

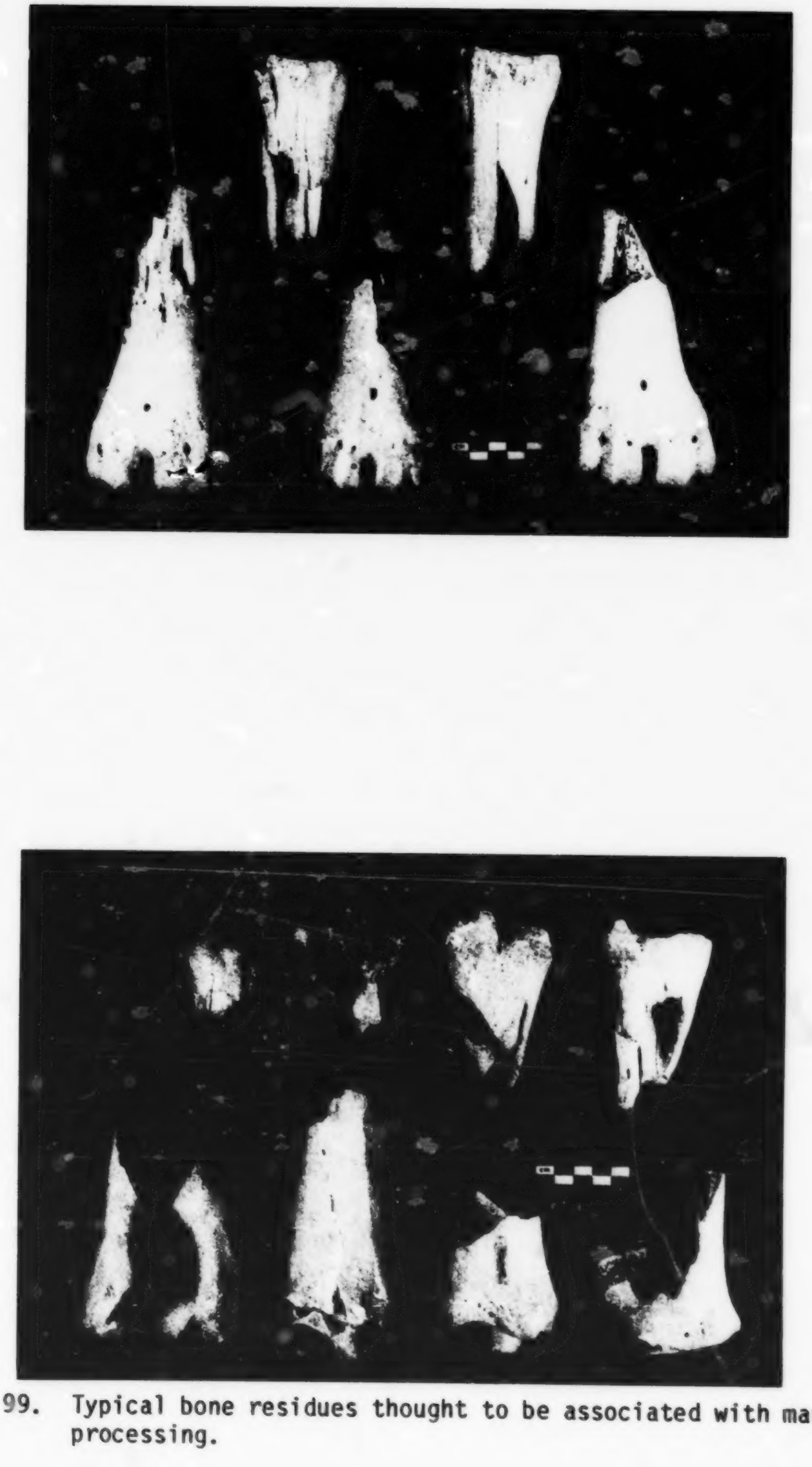

Figure 99. Typical bone residues thought to be associated with marrow processing.

processing. Because of these material requirements and the substantial outlays of time required to complete the degreasing process, it is questionable whether this task ever constituted a significant portion of the activities conducted in the HSI camp and processing site (Brink et al. 1985). Although it is impossible to determine how important or unimportant this task may have been prehistorically, or the exact set of circumstances that were requisite for undertaking grease processing (e.g., material supplies, labour, needs, etc.), we are confident that this particular task should not be viewed as a corollary of the successful operation of the HSI jump. In fact, we suspect that this particular variety of bone processing is often inappropriately assigned to bone residues that are the result of other cultural activities and taphonomic processes.

The evidence for marrow processing was evaluated on the basis of the articular portions of bison cannon bones (i.e., metacarpal, metatarsal and metapodial). The selection of this suite of elements was motivated by a desire to obviate the effects of secondary bone processing (i.e., grease extraction) by selecting elements which provide marrow and yet have minimal value as a source of grease. The distribution of proximal and distal portions of bison cannon bones is compared with that of appendicular remains in Figure 100. Two concentrations are evident, and these coincide with the locations of features known to contain large numbers of appendicular remains. It was originally hypothesized that marrow processing need not necessarily be associated with pit feature usage and, therefore, the close association of these bone residues and pit locations may question the validity of an exclusive marrow processng event in these two areas. It is possible that the bones were broken for marrow extraction during the course of other activities (i.e., cooking meat, making bone soup) and, therefore, do not represent the primary activity in these areas.

Evidence in support of this latter conjecture is revealed in the distribution of the low value grease bones (cf. reverse utility index, Thomas and Mayer 1983:367) that would remain as residues after the processing of grease rich bones. Two sets of bone distribution maps are evaluated below; the first considers the remains of the forelimb (e.g.,

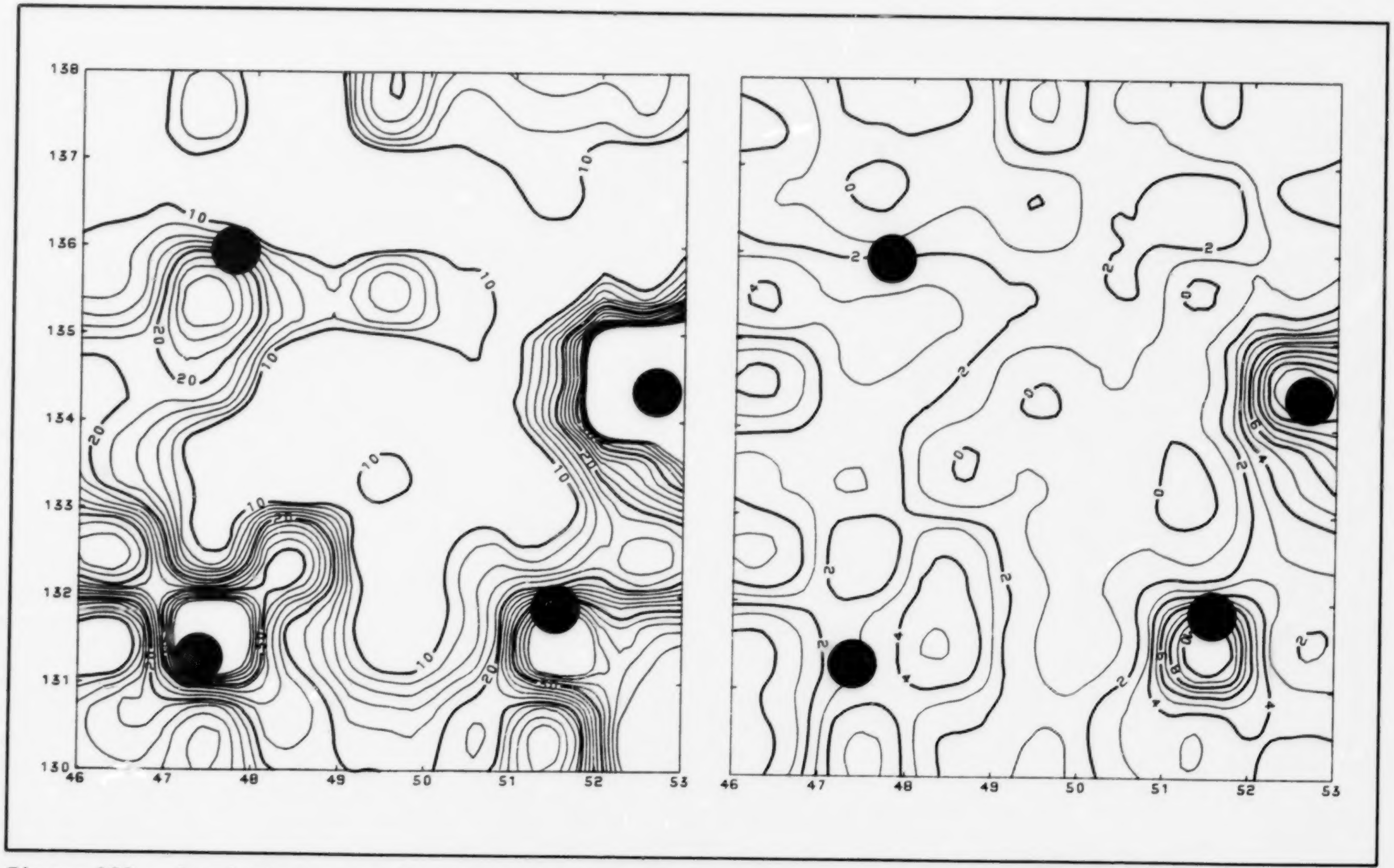
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Figure 100. Isopleth maps of bison appendicular (left) and cannon bone (right) distributions in the block excavation.

humerus, radius and ulna) while the second evaluates the rear limb element portions (e.g., femur, tibia).

The evaluation of the forelimb elements is conducted using two distribution plots (Figure 101). The first map illustrates the locations of all forelimb elements and includes all portions of those elements. The second map illustrates these bone portions which would remain if the bone had been processed for grease (i.e., distal humerus, humerus shaft, distal radius/ulna). It is clear that the distributions are very similar, and this is to be expected given the fact that some of the bones occur in both plots. By comparing the two plots, it is possible to determine which element portions are making up the majority of the concentrations found within the block excavation. For example, the concentration of elements in the northwest quadrant of the forelimb plot reveals isoline levels of eight elements, while the same area on the grease plot reveals levels of seven isolines. The implication of these measures is that the majority of this concentration is composed of the limb portions we would predict to be present if grease processing had been undertaken. The remaining concentration in the southeast corner of the unit reveals an equal proportion of "degreased bones" to non-degreased bone and no task specific activity is determinable based on these data.

The distribution plots for rear limb bone are presented in Figure 102, and these provide some corroborative evidence for the interpretations offered with respect to forelimb bones. The plot of rear limb elements reveals essentially the same concentrations of remains as was noted for the forelimb elements. It is also evident that a consistent relationship exists between the north half and southeast quadrant concentrations; that is, the proportion of degreased to non-degreased bone is essentially similar to that revealed in the distribution of forelimb elements. However, there is a notable difference in the positioning of the northern concentration in that it is located approximately one and a half metres to the east of the forelimb concentration (see Figures 101 and 102). Like the situation noted for forelimbs, the concentration of rear limbs in this particular area is primarily composed of degreased bone (i.e., proximal femur, femur shaft, distal tibia, tibia shaft). This evidence clearly supports the contention that a discrete activity was conducted in this area of the

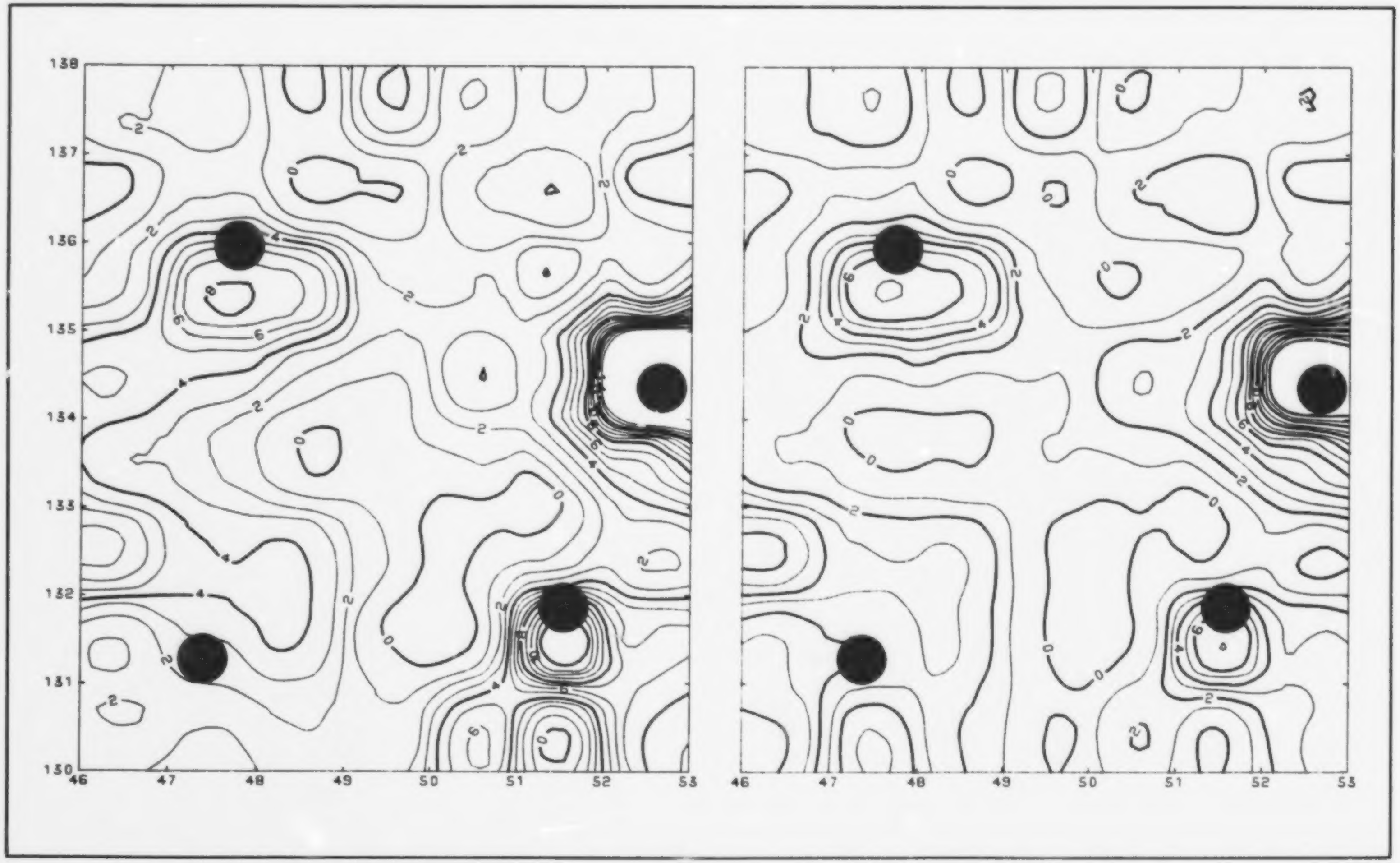
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Figure 101. Isopleth maps of all forelimb bones (left plot) and inverse grease index forelimb bones (right plot) in the block excavation.

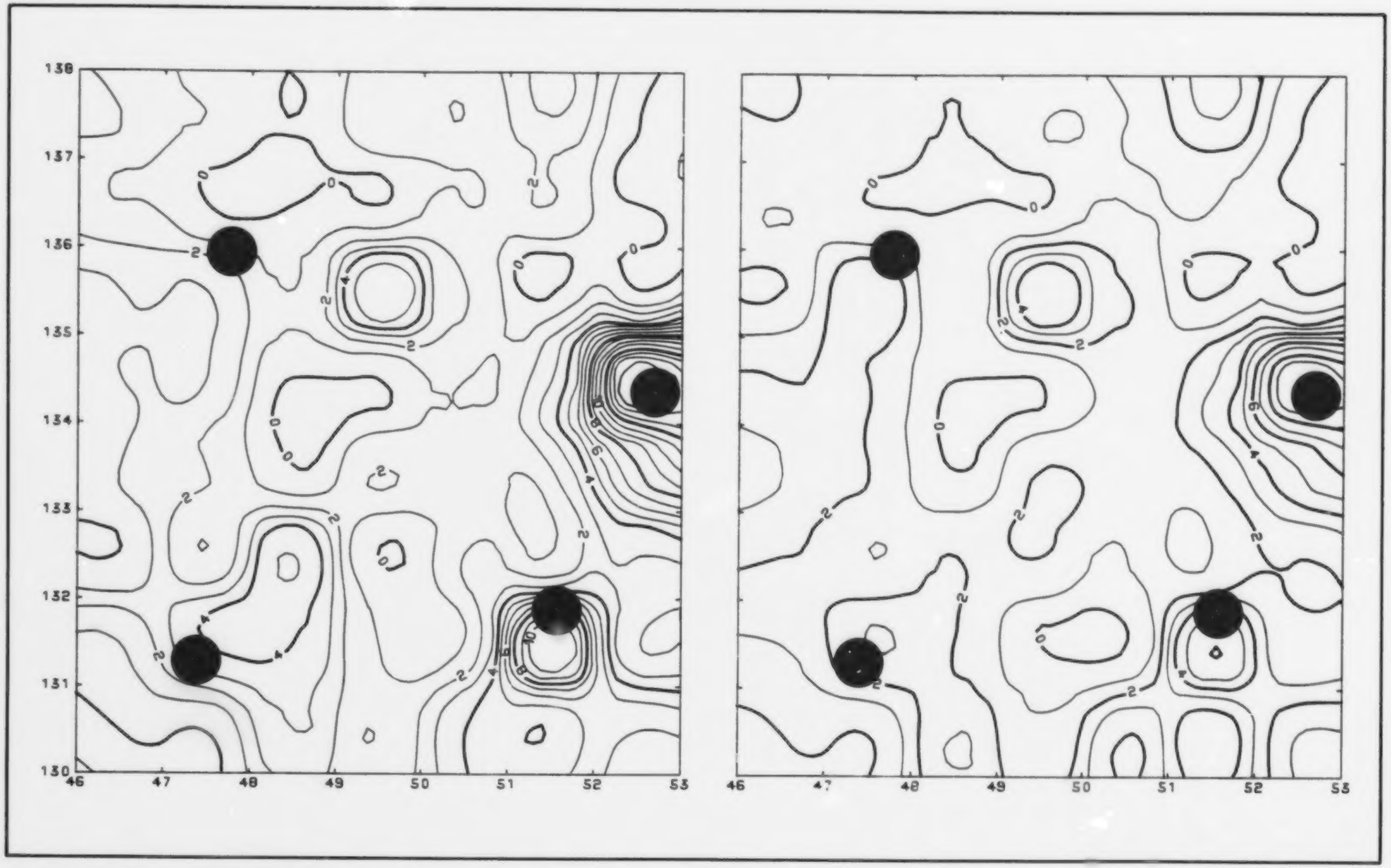
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Figure 102. Isopleth maps of all rear limb bones (left plot) and inverse grease index rear limb bones (right plot) in the block excavation.

block excavation, where both rear limb and forelimb bone elements are thought to have been reduced for purposes of obtaining bone grease. The fact that the two distributions are spatially discrete may imply that separate episodes are represented, or perhaps separate individuals were engaged in a single activity. Although it is possible that some selection was made for forelimbs over rear limbs, it is difficult to believe that such selection would exclude the joint processing of these limbs. It seems most reasonable that both the fore and rear limbs of a single animal would be processed together and that, therefore, the most likely scenario would have two individuals involved in the creation of the northern quadrant bone concentration. Although this reconstruction of events is speculative, it stands as the most probable interpretation of the evidence of hand, and is plausible in the context of the camp and processing site.

The evaluation of intra-site spatial patterning of the camp and processing site archaeological residues has provided some insights into the structure of this complex record of prehistoric activity. Perhaps more importantly, the analysis has shown that despite a non-stratified deposit and adverse taphonomic factors, it is still possible to discuss site structure and to extract residual patterning from a superimposed archaeological record.

CHAPTER FOUR

A RESEARCH DESIGN FOR THE EXPERIMENTAL STUDY OF BISON BONE TAPHONOMY

INTRODUCTION

The archaeological test excavations at the Head-Smashed-In Buffalo Jump site conducted to date have been focussed on the camp and processing site which is situated on the prairie below the main kill and bone bed deposits. The campsite and processing area covers approximately 25 hectares of these prairie flats, and is represented by a dense but shallow layer of broken bison bone, fire broken rock, lithics and features (Brink et al. 1985). The interpretation of these deposits is complicated by a number of factors, one of which involves the identification of bone fragmentation that is the result of cultural as opposed to taphonomic agencies.

Bone fragmentation at Head-Smashed-In is extreme, and this has led to suggestions that the inhabitants of the site were engaged in processing bone, including marrow extraction and bone boiling for rendering grease. It is evident, however, that natural agencies can contribute to the fragmentation of bone (Behrensmeyer et al. 1979; Binford and Bertram 1977), hence the need to be cautious in the identification of what constitutes culturally modified bone (Todd 1983).

There have been a number of studies conducted on both fossil and modern bone assemblages which seek to identify the distinguishing hallmarks of cultural and natural bone residues (Behrensmeyer and Boaz 1980; Hill 1979; Sadek-Kooros 1975; Thomas 1971). Several of these studies have involved the long term observation of man-made and natural bone accumulations in Old World settings (Behrensmeyer and Hill 1980; Brain 1981; Miller 1975). Less common are similar studies employing North American environments and species (Haynes 1982, 1983; Morlan 1980; Todd 1983; Voorhies 1969).

The taphonomic study of bison bone deterioration in a prairie environment will provide much needed material for purposes of analysing the fragmented bone from Head-Smashed-In as well as other plains sites. The primary objective here is to generate reliable criteria to aid in the distinguishing of bone which has been modified by people from that which has been modified by non-human agencies. Such studies are currently underway (Todd 1983) but much more needs to be done. With this in mind, a research design for the long term observation of bison bone deterioration in a prairie setting was assembled and implemented at the Head-Smashed-In site. This report documents the design of the experimental programme and reviews the various questions that can hopefully be addressed with the data gathered from these plots over the next several years.

RESEARCH DESIGN

The evaluation of taphonomic agencies which act upon bone involves the consideration of many factors. These include chemical alteration (Hare 1980), weathering (Behrensmeyer 1978, Miller 1975) and carnivore activity (Haynes 1983). For the purposes of the Head-Smashed-In project, only weathering and carnivore activity will be evaluated. The bone elements utilized in the study were obtained from three bison carcasses from the Elk Island National Park herd of plains bison (Bison bison bison). All the animals were shot in February 1984, and the elements were collected on March 28, 1984. Thus, from the time of death to the time of bone collection the animal carcasses were either frozen or at temperatures very near freezing, resulting in little or no deterioration of the bone. The breakdown of elements is presented in Table 29. The animals were all bulls, and all were mature at time of death (i.e., greater than five years).

Some carnivore scavenging of the carcasses was evident, but most of this activity did not involve the bone. An effort was made to select elements with only minimal or no carnivore damage so that subsequent alterations might be readily identified. Bone elements selected were carefully examined and notations made of any carnivore damage. The majority of the elements retained a complete periosteum membrane and some were still covered with flesh and hide.

All the elements were placed within experimental plots without further alteration, except for the right rear limb located in plot one. Using a sandstone anvil and a quartzite cobble hammer, we fractured

Table 29. Bison elements used in taphonomic plots.

Plot No.	Elements	Age	Side	Condition	Surface Exposed
One	Rear limb - calcaneous to the third phalange less the astragalus	5 yrs	R	Marrow fractured metatarsal	Anterior
	Rear limb - " "	5 yrs	L	--	Posterior
	Ribs - three complete #4,5,6	5 yrs	L	--	--
	Scapula	5 yrs	L	--	Superior
Two	Forelimb - humerus to third phalange	8 yrs	R	--	Medial
	Forelimb - " " "	8 yrs	L	Minor gnawing missing periosteum on 20% of bone surface	Lateral
Three	Vertebral column - from the 6th cervical to 1st lumbar, includes ribs 2,3 from left and right sides	5 yrs	-	Periosteum missing on most bone - minor gnawing of rib ends	Left Superior
Four	Forelimb - Humerus to third phalange	5 yrs	R	--	Medial
	Rear limb - Femur to third phalange, patella missing	5 yrs	R	--	Lateral

the mid-diaphysis of the metatarsal to expose the bone marrow cavity (Table 29). The intent of this alteration was to create some small bone fragments to help evaluate whether the broken portions of the element weathered more rapidly than the unaltered metatarsals. Also, we suspect that carnivore activity will vary depending on the ease or difficulty of attacking specific bones. The broken metatarsal should be especially attractive to carnivores. The fragments produced by the fracture were all small chips (less than 2 cm), some of which remained attached to the element by the periosteum membrane.

It is suspected that some of the bone fragments recovered from the camp and processing area are the result of marrow extraction activities, but it is unclear how these fragments would differ from naturally produced fragments (Brink et al. 1985; Vehik 1977). During the course of the experiment, the fragments will undergo weathering processes similar to those thought to have been active prehistorically. This may help separate the hallmarks of natural bone weathering from intentional bone breakage. Qualitatively, bone fragments produced by us are rounded and thin compared to the thick square columnar fragments that are known to be produced as a result of weathering (Behrensmeyer 1978; Miller 1975; Tappen and Peske 1970).

The bone elements were placed within four experimental plots that are located on slightly sloping short grass prairie below the Head-Smashed-In escarpment 200 m north of the block excavation area (see Figure 2). Each plot measured two metres square and was positioned within a master grid measuring 20 m on a side (Figure 103). The discussion which follows presents the details of the individual plots, including elements employed, orientation of the bone and the bone surface exposed.

Experimental plot one

This plot contains two rear limb portions, three ribs and a scapula (see Table 29 and Figure 104). Two of the ribs are oriented east-west with the remainder of the bone elements aligned north-south. The ribs are all placed on their caudal edge with the cranial aspect exposed. All of the ribs retained a partial covering of flesh with the periosteum intact. No gnawing was evident on any of the specimens. The two rear limb portions were aligned north-south with the distal ends pointed

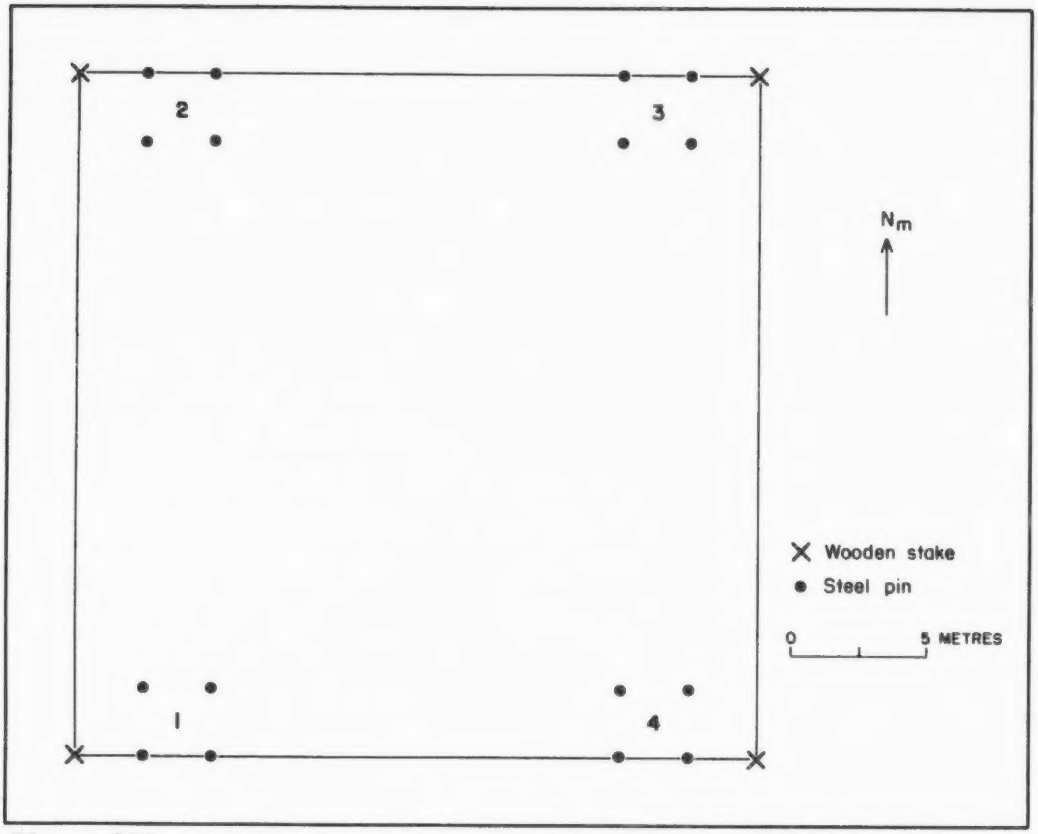


Figure 103. Layout of experimental taphonomic plots.

south. Both specimens retained flesh and periosteum membranes, with hide covering the limb below the distal end of the metatarsal. The hoof sheaths were intact.

As mentioned above, one of these elements was modified by breaking of the metatarsal mid-shaft. This specimen was placed with the anterior surface face up. The remaining limb portion was placed with the posterior surface exposed. This positioning should help to assess whether the bone surface exposed has any influence on the deterioration of the element through time.

The last specimen in the group is a complete scapula; it was oriented with the distal end facing south and the superior surface face up. The scapula retained a complete covering of flesh and periosteum, but there was some minor gnawing of the cartilaginous tissue along the distal end of the element.

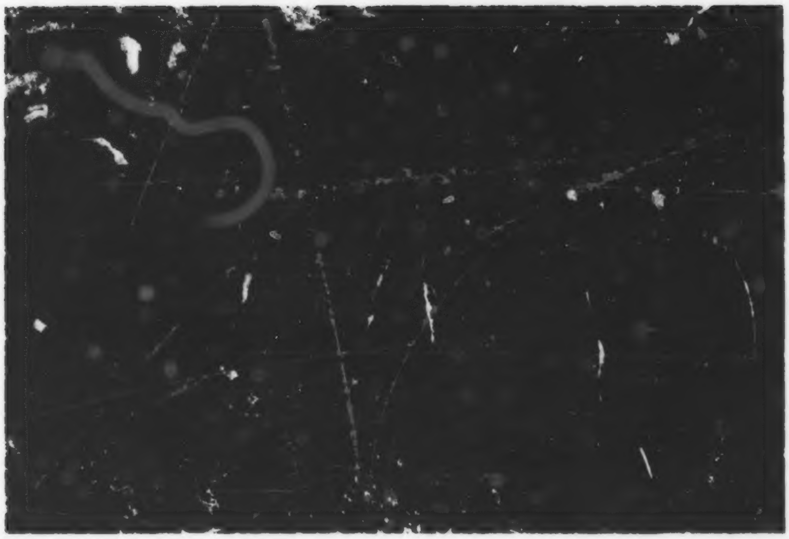


Figure 104. Taphonomic plots one (upper) and two (lower).

Experimental plot two

This plot contained two forelimbs, both oriented north-south with the distal ends facing south. The elements were complete from the proximal end of the humerus, and the hoof sheaths were intact (Figure 104). The right limb was placed with its medial surface face up. There was no evidence of gnawing on this specimen. Virtually all of the periosteum was intact along with some fleshy membranes and minor quantities of hide.

The left limb was in much the same condition as the right except for some evidence of gnawing on the proximal epiphysis of the humerus and the proximal end of the ulna. In order to contrast the weathering of the right limb, the left forelimb was placed with its lateral surface exposed.

Experimental plot three

This plot contained a single bone unit consisting of a vertebral column beginning with the 6th cervical vertebra and ending with the 1st lumbar vertebra. Only the second and third rib elements remain attached to the vertebral column (Figure 105). The periosteum is missing from many of the boss ribs and from the second and third ribs. There is evidence of gnawing on the distal end of the thoracic spines and some of the ribs. Although the vertebral column appears articulated, there was a disarticulation between the second and third thoracic vertebrae. The bone unit was placed on its right side with the superior surface of the left side exposed. The axial bone unit was orientated north-south with the anterior aspect facing south.

Experimental plot four

The last experimental plot consisted of both a fore and rear limb unit, both of which were oriented north-south, perpendicular to the local slope (Figure 105). The right forelimb is complete from the proximal end of the humerus to the intact hoof sheaths. All of the bone is covered with flesh and periosteum, and the bone below the distal end of the radius is completely hide covered. The bone unit was placed with the medial surface facing upwards.

The left rear limb is also complete from the proximal end of the femur to the intact hoof sheaths. Although the patella is missing, the remainder of the bone unit retains flesh and periosteum coverings with

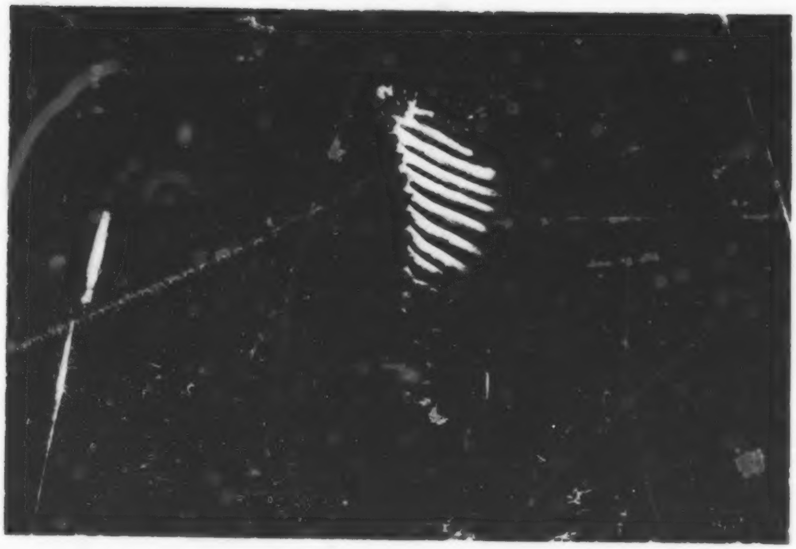


Figure 105. Taphonomic plots three (upper) and four (lower).

intact hide portions below the mid-shaft of the metatarsal. Like the right forelimb, the rear limb was placed with the medial surface uppermost.

INITIAL OBSERVATIONS AND RESEARCH PROBLEMS

The experimental plots described above were set up in August of 1984. The experimental plots have been examined twice since this time, once in the late fall of 1984 and during the summer of 1985. Although it was anticipated that some of the bone would be transported by medium sized carnivores (i.e., coyote and wolf), we grossly underestimated the extent of this movement.

All of the bones had been moved from their original locations. In the case of one limb from plot four, this movement entailed only a few metres of downslope displacement. The axial element assemblage in plot three was also only moved a few metres and this too was downslope. However, the majority of the bone elements were well outside the experimental grid, sometimes in excess of 100 m, and a variety of elements simply could not be relocated. It was obvious that carnivores were removing these elements, and it is suspected that a deep gully to the east of the plot was the destination of much of this transport (see Figure 2). This channel would have provided both protection from the elements and seclusion for the consumption of our experimental materials.

The loss of several elements and extensive transport of others effectively negates the observation of weathering hallmarks on these bones. Obviously, the careful placement and observation of bone repose has been rendered unimportant by virtue of this excessive movement. The fact that single bones and readily maneuvered sections of bone (i.e., whole limbs) were employed no doubt facilitated the dispersal of the assemblage. When the specimens were originally collected from Elk Island, they occurred as individual carcasses, and it was evident that removal and transport of bone portions was minimal (Figures 106 and 107). Faced with the abundance of soft tissue from three adult male bison, it seems unlikely that the bone would be scavenged until much later in the taphonomic time frame. Presumably, the same situation would have occurred in the prehistoric setting of the HSI kill and processing

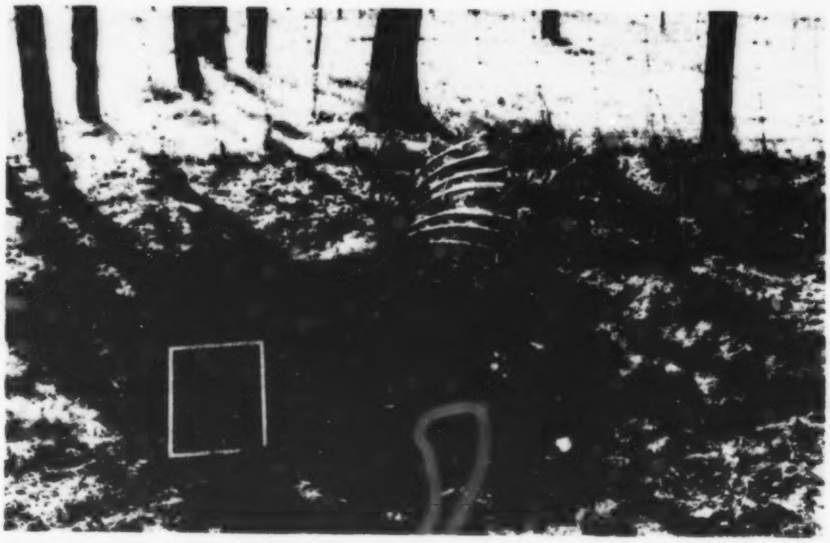


Figure 106. Elk Island bison carcass number one.

Figure 107. Elk Island bison carcass number three.

site, where the abundance in the kill would divert the scavengers from the processing site. This would reduce the transport of the processing site remains, leaving trampling and weathering as the primary taphonomic agencies of bone deterioration.

In the case of our 1984 test plot, the exposed bone acted as a magnet for local scavengers. Thus, some means of securing the bone will be required in order for long term weathering patterns to be observed. Additional bone samples gathered in 1985 will be used for this purpose, and a modified experimental plot will be installed at the site in the future. Although the 1984 experimental design proved inoperable as a long term field study, some observations were forthcoming.

On initial exposure the bone was immediately infested witn flies and ants, whose efforts were concentrated mostly on the exposed fleshy portions. After a few days, moist areas on the exposed surface became hard and dry, and the insect activity was focussed on the underside of the bone which was still quite moist. In addition to the ant and fly populations, several varieties of beetle were observed beneath many of the elements. It was also clear that a good deal of fluid was being deposited under the bone, as the ground was quite greasy looking and darker than the surrounding areas. The effect of direct sunlight and high temperatures (30°C plus) may have promoted the "sweating" of oils from the flesh and membranes and marrow grease from the bones. This seemed to provide an ideal environment for some of the insects, especially the beetle species.

There are several basic questions that we hope to address with the data gathered from experimental bone plots. The following list is not exhaustive. It simply represents our initial queries which arose during the analysis of the 1983 assemblage from Head-Smashed-In (Brink et al. 1985). First, do all bones weather at equal rates, or do some bones or bone portions tend to break down more rapidly than others? This may help to explain why only some elements or element portions are present in the camp and processing site, recognizing, of course, that some cultural selection of elements may be occurring between the primary butchering at the kill site and subsequent butchering at the processing site. However, in order to assess what cultural selection is occurring, it is necessary to know which bison elements would be more likely to be removed from the assemblage by means of weathering or carnivore activity alone.

For example, the processing site has yielded substantial numbers of astragalii, and we suspect that this is due to three factors. First, for reasons of nutrition or for making tools, there is little reason to process bison astragalii. Second, the positioning of this element within a dense mass of sinew, cartilage and hide would effectively protect this element for an extended period of time, much more so than the upper limb elements. Finally, the rounded shape, coupled with the dense, compact nature of the bone increases the likelihood of astragalii survival.

We would also like to know how long it takes for the grease content of the bone to be weathered out, for this may determine what time of year stockpiling of marrow and grease bones may have been practicable and which elements were stored. We suspect that the storage of "marrow bones" could only occur in the late fall, winter and early spring periods, if the grease was to survive without undue loss of its nutrient value (Wilson 1924:174). It may prove to be the case that some bones retain some grease even after a full season of exposure on the prairie. This could influence both carnivore and cultural modification of the bone long after initial deposition.

The rate of bone weathering has been addressed by a number of authors, but it has yet to be well documented in the case of North American species. Over the course of the study, the weathering rates established by Behrensmeyer (1978) will be compared to the experimental data, and revised weathering stages thereby established for plains prairie environments. Variations in the weathering of the bone assemblage may be of assistance in examining the periodicity of bone accumulation at Head-Smashed-In. For example, the presence of each stage of bone weathering would be indicative of a slowly accumulating assemblage, whereas large numbers of bones at the same weathering stage may indicate a single event representing a massive deposition of bone (Behrensmeyer 1978:161-162). The presence of well preserved, non-weathered bone could be indicative of micro-environmental variation at the Head-Smashed-In site and may help identify areas of rapid sedimentation or prolonged snow cover (Todd 1983), or mass disposal of butchering residues. The results of the taphonomy experiments are not likely to answer all the aforementioned questions, but they should provide some initial long term observations of bison bone alteration that will help interpret the prehistoric bone residues currently under evaluation.

CHAPTER FIVE

EXPERIMENTAL RESULTS AND OBSERVATIONS RELATING TO PREHISTORIC FUELS, HEARTHS AND BOILING PITS

INTRODUCTION

A variety of hearth and pit features, thought to be the result of processing bison meat and by-products, have been recorded at Head-Smashed-In (Brink et al. 1985). The vast quantities of fragmented bison bone and fire broken rock associated with these features suggest that cooking with boiling stones and bone processing for both marrow and grease extraction were undertaken at the site. In order to better understand the material requirements, time and labour allocations and probable archaeological residues of such activities, a series of replicative experiments were designed and initiated during the course of the 1984 field season. The results of these experiments will be useful as analogues for the interpretation of prehistoric residues of bone, stone and features that occur in the archaeological deposits of the main camp and processing area of the site.

The issue of local resource availability is of particular importance in interpreting the archaeological residues at Head-Smashed-In because there are no abundant sources of wood fuel or river cobbles in the immediate site area. This prompted the speculation that bison dung was the primary fuel utilized and that river cobbles were transported to the site from known sources located 1 to 2 km east of the site. Despite the vast quantities of sandstone available in the immediate site area, it formed only 15% of the 1984 FBR assemblage, suggesting that some properties of this stone make it unsuitable for boiling stone technology. To help clarify this situation, both river cobbles and local sandstone were employed in the experiments to determine their relative efficiency for purposes of heating stones and raising the temperature of a known volume of water.

The results of the experiments are restricted to a discussion of preliminary observations and qualitative statements until additional experiments can be completed in 1985. Because of the number of variables being considered and the limited number of experimental trials completed to date, no definitive statements are possible at this time with respect to the material and pit facilities that were evaluated. As this was the first year of the experimental study, the procedures employed can be expected to be modified in subsequent years. The trial and error phase of the first year does not negate the importance of the initial results, but it is important that they be viewed from the perspective of being preliminary and necessarily speculative in tone.

This report is presented in four sections. The first section discusses the background to the research, summarizing the motivation for the study, the ethnographic data employed and the results of other replicative studies dealing with the topic. Details regarding the research design are presented in the second section and include discussion of the materials employed, pit facility design and methodology. The study results are detailed in the third section, dealing with the various types of fuel employed, hearth facilities, boiling stone properties and boiling pit facilities. In the fourth and final section, some preliminary conclusions are offered and directions for future studies are discussed.

BACKGROUND

The Head-Smashed-In Buffalo Jump site has been under archaeological investigation since the late 1930s. As with most bison jump sites, the bulk of these investigations have been focussed on the bone bed deposits of the kill site. While most jump sites consist of a set of constituent parts including a gathering basin, drive lanes, jump site and camp/processing area, the latter component remains the least understood. In many instances, the camp and processing areas associated with jump sites have never been investigated and their composition remains enigmatic. This is a curious situation, for it is evident from ethnographic accounts that the preparations prior to a jumping event, which would include establishing the camp, repairing drive lanes, and orchestration of the hunt, represent a great deal of time and activity in the camp areas. Following the short-lived excitement of the drive and jump event, the real work would begin, for the bison carcasses would need to be processed prior to spoilage. Much of this work would have been conducted in the camp and processing site and probably would have included secondary butchering, meat drying, hide preparation and extraction of bison by-products (i.e., sinew, gut bags, bone grease, glue, etc. [see Verbicky-Todd 1984]). In the absence of these well ordered, intensive and protracted processing activities, much of the resources garnered by the jump event would be lost due to spoilage. In fact, a well ordered and competent camp/processing site is likely to have been as crucial to a successful hunt as the preparation of drive lanes and the actual driving of the bison.

The research being conducted at Head-Smashed-In has focussed attention on the large camp and processing site which occupies approximately 25 hectares of the prairie flats below the jump site (see Figure 2). While the immediate purpose of this research has been the mitigation of the various developments associated with the installation of a Visitor Reception Centre (Brink et al. 1985), the ultimate objective is the evaluation of activities and organization of the camp and processing site. This investigation has been complicated by the nature of the archaeological deposits in the camp/processing site. Unlike the well stratified deposits of the kill site bone bed (Reeves 1978, 1983b), the camp area is a deflation surface. Many thousands of years of occupation have been compressed into a dense 25 cm thick deposit of bison bone, fire broken rock and loess.

A variety of distinct hearth and pit features occur throughout this undifferentiated cultural deposit. These features are representative of particular events in the past and retain a contextual integrity that is absent from general subsurface scatter of broken bone and fire broken rock. The features provide a synchronic perspective on the camp and processing site deposits, but they also provide information about the activities that were associated with their use by virtue of their morphology and contents.

The preservation of cultural remains at Head-Smashed-In is greatly enhanced by rapid burial. It is evident that most of the less resistant material, such as bone and ceramics, would have been quickly reduced to small fragments by the conditions prevalent in the core area of the Head-Smashed-In processing site. These taphonomic effects have been discussed in detail elsewhere (Brink et al. 1985) and include trampling by ungulates and man, chemical reduction by plants and ground water, and a variety of physical weathering agents such as freeze-thaw, wind and sun exposure. In the final analysis, much of the bone at Head-Smashed-In has been so severely weathered that it cannot be used to reconstruct the butchering and processing activities which have taken place in the camp and processing area. Features, because of the relatively rapid burial of their contents, provide a wealth of information that can be of assistance in reconstructing the secondary butchering and processing practices that would have absorbed much of the people's time following the jumping event.

Although most plains sites have produced a variety of features (including the ubiquitous hearth stain), interpretation of these remains has suffered from the lack of good comparative data. With a few notable exceptions (Congram 1978; Guernsey 1984; Munson 1984; Quigg 1975; Syms 1974), the archaeological study of features has been very uneven and largely reliant on simple description. Such descriptions are not sufficient for purposes of comparative analysis, and provide only a qualitative impression of inter-site feature variability.

Despite the lack of comparative study of feature assemblages, archaeologists persist in assigning particularistic functions to the features they excavate. These include designations such as roasting pit, boiling pit, the enigmatic bone uprights and bone pegs, and surficial concentrations of fire broken rock and bone that may be the residues of pit cleaning activities or suspended pits (Munson 1984).

The ethnographic descriptions of these features are often lacking in some basic details necessary for their adoption as ethnographic analogs for archaeological residues. For example, the size and morphology of the pit would be a useful index of similarity for purposes of establishing analogs, yet only a handful of ethnographic accounts actually record the dimensions of subsurface pit features (Smith and Cole-Will 1984). Similarly, the contents of the ethnographically documented pits are usually only recorded in general terms, so the archaeological residues can not be specifically compared. This is of some importance for the identification of bone boiling and bone roasting pits, given that the bone elements employed are probably different in each circumstance.

The upshot of the ethnographic accounts of bison processing activities and pit usage is that we know very little about the camp environment of plains groups. This may be due to the mundane nature of these camp tasks and the ethnographers' bent to record the more notable and immediate (usually male oriented) activities such as the organization of the hunt, the coercion and stampeding of the herd and the primary butchering of the carcasses. It would be interesting to know whether some of the processing activities such as marrow extraction and bone grease rendering were conducted communally in an "assembly line" production employing one or two large boiling pits (cf. Binford 1978). Likewise, it would be useful to know if roasting pits were employed communally, and whether they were situated in a specific location relative to habitations or exterior work areas. Many of these questions could be addressed using archaeological data but only if the functional aspects of ethnographically recorded features can be documented with some certainty.

The lack of detailed ethnographic analogs for some archaeological residues has prompted the adoption of experimental and replicative studies in archaeological research. This approach is not new in the Old World school of archaeological research but is rather innovative with respect to New World studies. Some activities have been replicated by experimental projects dealing with prehistoric cooking technologies and evaluation of fuels. The thermal properties of specific types of fuel have been evaluated (Holland 1984; Johnson 1977), as have boiling stone materials (House and Smith 1975; Lorrain 1973; McDowell-Loudan 1983), which appear to have been used extensively in plains cooking technology. Meat boiling may have been adopted because of culinary preference or to maximize the available fuel stores, but it appears that a significant amount of time was devoted to this activity at Head-Smashed-In during the late prehistoric period.

We suspect that the importation of quartzite and limestone cobble boiling stone materials to the near exclusion of locally abundant sandstone underscores the functional properties of each lithology. Similarly, the absence of wood fuel in the immediate vicinity of Head-Smashed-In would argue that dried bison dung was the primary fuel. But what are the properties of bison chip fuel? Is it useful for purposes of heating stone for boiling pits as well as producing heat and light for the interiors of habitations? How much chip fuel needs to be gathered to cook a given quantity of meat or degrease a volume of bone fragments? None of these questions are answerable given the current experimental assessment of bison chips as a fuel (Holland 1984). In fact, much of the information that is currently circulating about chip fuel appears to be rather coarse qualitative data associated with incidental observations made during the course of pottery replication studies (Ian Dyck pers. comm. 1984; Johnson 1977). In some cases, these observations run contrary to one another; one will pronounce chips an excellent fuel which yields high heat, while others find that chips are much inferior to wood fuel.

The purpose of the experimental studies reported herein is to quantify some of the properties of chip fuel and evaluate the characteristics of different boiling stone materials and various types of hearths and pit features. The results of these studies will assist in exploration of the archaeological residues at Head-Smashed-In and help to gain a better understanding of the kinds of activities that were conducted in the camp and processing site.

RESEARCH DESIGN

This section outlines the materials used in the experiments, the morphology of the pit facilities employed, and the methodology of the study. Finally, a series of questions are posed in the form of hypotheses to be tested during the course of the evaluations.

Material Resources

Two varieties of fuel and two varieties of boiling stone were used in this study. Some of these resources are available in the immediate site area; others had to be imported from distances of several kilometres.

Fuel

One GMC Suburban load of bison chips was collected from a bison paddock near Del Bonita, Alberta. The chips were less than a year old, but sufficiently seasoned to require only limited drying prior to initiating the experiment. The process of gathering the chips was completed by one person in about one hour and within the bounds of a four hectare area. The major problem with gathering chips is the transportation of same back to a base camp. Owing to the bulk of this commodity, in pre-Suburban times it would have required a large scale communal effort to transport sufficient quantities of fuel to the camp site. It is likely that all members of the group were enlisted for this task, including the very young and the very old.

The wood fuel was obtained from a forestry reserve approximately 40 km west of the site. Closer sources of wood were available (Oldman River) but they were inaccessible by vehicle. Pine, spruce and poplar, as well as an unidentified shrub which may have been silver berry, were obtained. The wood was broken and cut into sections for sake of convenience, but it is unlikely that this procedure would have been followed prehistorically. The individual piles of wood measured approximately three feet on a side (1/20 of a cord) and required three hours of collection by two people. Again, transportation of the fuel constituted the most labour intensive part of the gathering process.

Stone

Two varieties of stone were employed in the study: local sandstone from the site escarpment, and quartzite and limestone cobbles from a gravel bed located 10 km east of the site. Closer sources of cobble stone are accessible by foot less than 2 km from the site. In an effort to assess the properties of discarded sandstone and cobble materials, a sample of each was taken from discarded fire broken rock recorded during the course of the 1984 excavation. The fact that cobble material is more prevalent at Head-Smashed-In and that this is imported material suggests that cobbles were probably recycled several times prior to final discard.

The sandstone slabs selected fell in the range of 10-15 cm on a side and were usually about 5 to 10 cm thick. Several large fragments in excess of 20 cm on a side were collected to determine if the size of material was an important consideration in the absorption and retention of heat. The cobble materials averaged between 10 and 15 cm in diameter, and preference was given to the more rounded specimens. It was observed that the sandstone materials were much easier to transport owing to their slab configuration which allowed stacking. The cobbles, which were notably heavier, would have presented a significant transportation problem and some form of container must have been employed prehistorically.

The proliferation of imported limestone and quartzite at Head-Smashed-In suggests that significant amounts of labour and time were devoted to the collection of these materials. For example, the 1983 and 1984 excavations in the processing area yielded an average of 21.2 and 37.8 kg of fire broken rock, respectively, for each square metre of excavated area. The composition of the FBR assemblages indicates that the proportion of imported to local stone is usually about 6 to 1. This means that the core processing area probably contains in excess of 200 tonnes of imported FBR, while the entire camp and processing site would contain nearly 1300 tonnes of this rock type. Although the accuracy of these figures can be debated, one point is clear: local rock resources are minimally employed and substantial effort and time were expended to obtain the imported rock. Presumably, the motivation for this impressive gathering exercise is rooted in the superior heating properties of cobble quartzites and limestones. The experiments which follow help to reveal these properties.

Facility Types

Hearths

Previous excavations at Head-Smashed-In revealed numerous shallow hearth stains that appeared to have no formal structure and extended only 2-5 cm into the subsoil (Brink et al. 1985). Hearths within pit depressions were rare and inevitably shallow, suggesting that most fires at Head-Smashed-In were short-lived and kindled with a minimum of preparation. No evidence of rock-ringed hearths has been recorded.

Construction of the experimental surface hearths involved clearing vegetation from a 90 cm diameter area, with the fires kindled directly on the subsoil. Although the experiments were not conducted on soils identical to the site area, they are comparable and the results are thought to provide accurate analogs for prehistoric surface hearths. The pit hearths were also 90 cm in diameter and excavated 15 cm into the subsoil to form a shallow basin depression (Figures 108, 109, and 110).

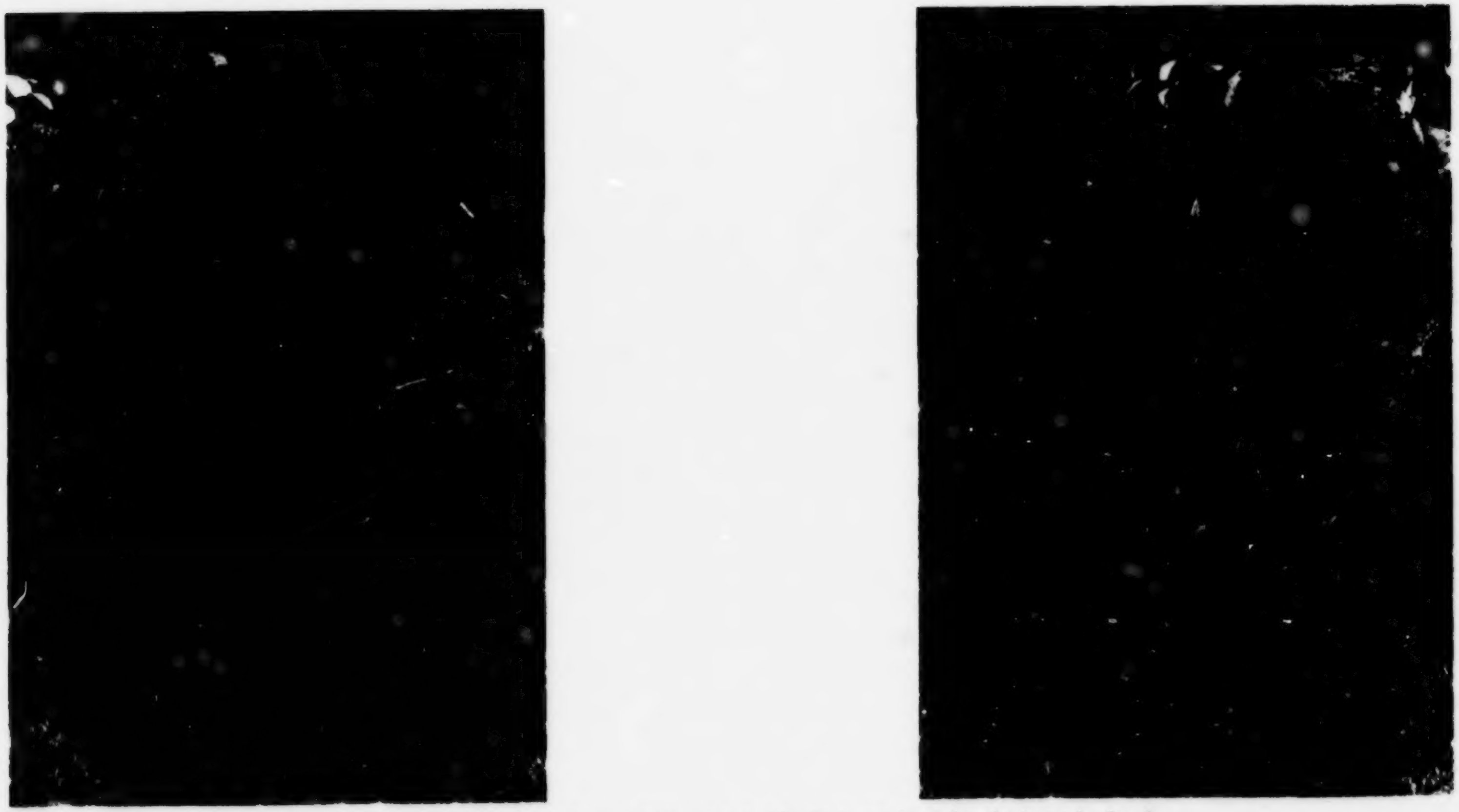


Figure 108. Photograph of hearth facilities with wood (left) and chip (right) fuels.

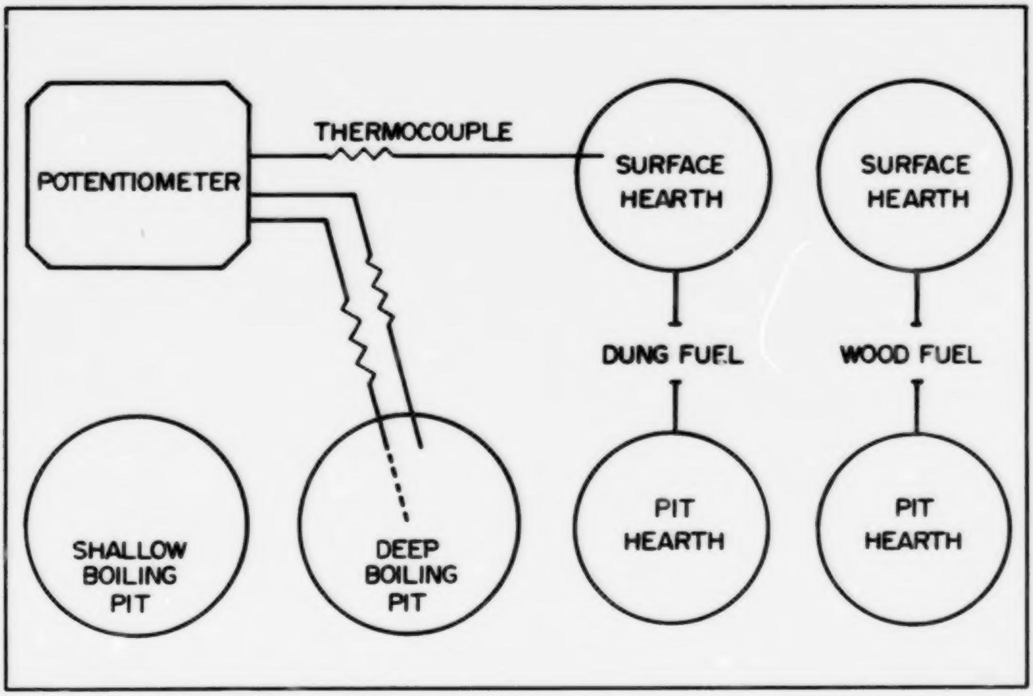

POTENTIOMETER
THERMOCOUPLE
SURFACE HEARTH
SURFACE HEARTH
DUNG FUEL
WOOD FUEL
SHALLOW BOILING PIT
DEEP BOILING PIT
PIT HEARTH
PIT HEARTH

Figure 109. Plan view of experimental plot.

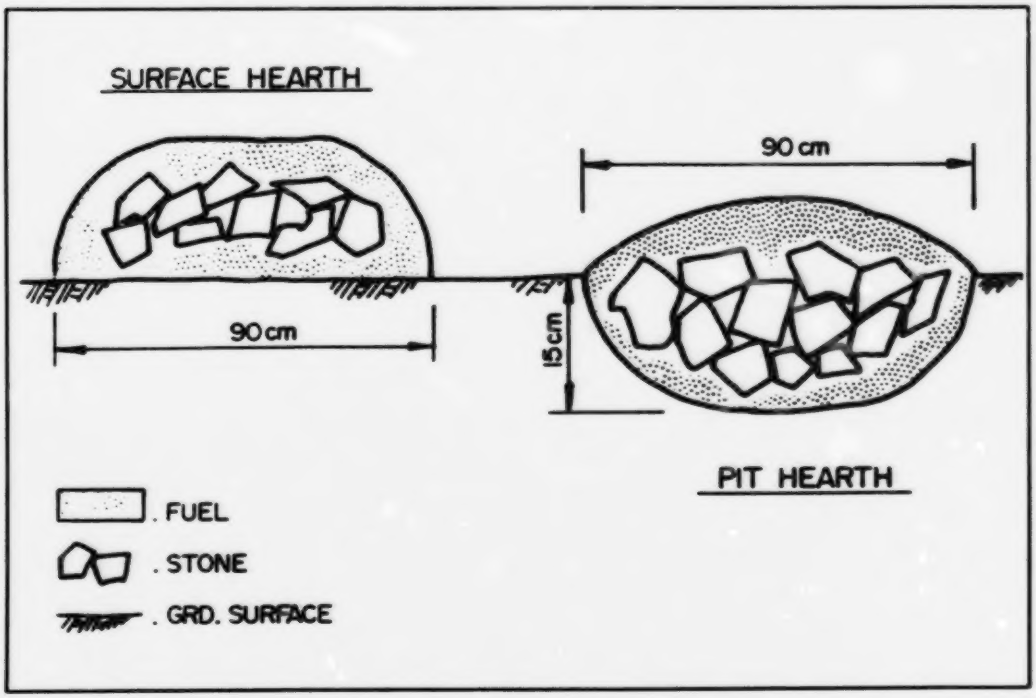

SURFACE HEARTH
90cm
90cm
15cm
PIT HEARTH
. FUEL
. STONE
. GRD. SURFACE

Figure 110. Profile of hearth types and fuel placement.

In order to evaluate differential heat transference from chip and wood fuel, separate hearth facilities were maintained for both fuel types.

Boiling pits

The two types of experimental boiling pits are idealized versions of pits that may have been used at Head-Smashed-In. Both held identical volumes of liquid, but the pits themselves were morphologically distinct (Figures 109, 111 and 112). The first pit was 50 cm in diameter and 80 cm deep, containing 90 litres of liquid. The second pit was much shallower but possessed a larger surface area, measuring 100 cm in diameter and 25 cm in depth. The rationale behind the two pit varieties is explained in the final part of this section.

Although prehistoric boiling pits would have been lined with a fresh bison hide, none was available and heavy gauge plastic was therefore employed. It is presumed that the hide would have provided the pit with improved insulation and would not have been as susceptible to puncture from the loading of sharp, angular fragments of fire broken rock. During the course of the experiments, both boiling pit liners had to be replaced several times due to punctures.

The perimeter of the shallow boiling pit was built up with a rim of earth derived from the excavation and stabilized with sandstone slabs. Similar structures have been recorded on plains archaeological sites (Frison 1967) and represent an expedient means of building a large pit without the labour of excavating a deep depression.

Methodology

Prior to each experimental trial, a number of tabulations and observations were completed. The experimental conditions were recorded, including the ambient air temperature, the surface temperature of the hearth to be used, and the surface and basal temperatures of the boiling pit being employed. Ambient air temperature was recorded with a thermometer while all the other temperatures were recorded with thermocouples attached to a potentiometer (see Figure 109). The fuel to be used was counted and stockpiled, and the stone to be heated was counted, size squared and weighed. The time of day was recorded, and the wind velocity and direction were noted.

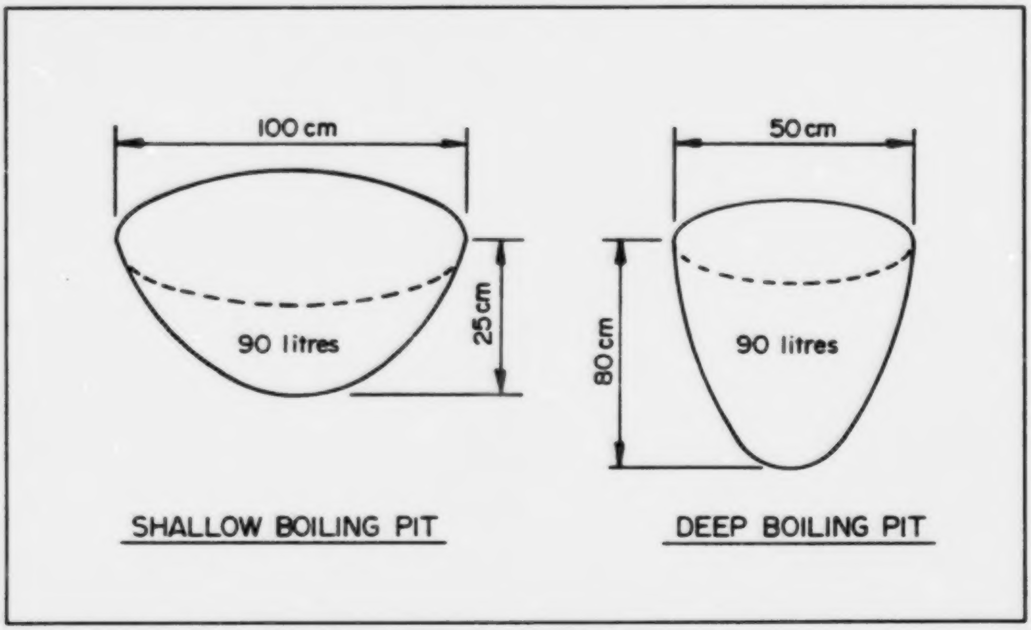

100 cm
50 cm
25 cm
80 cm
90 litres
90 litres
SHALLOW BOILING PIT
DEEP BOILING PIT

Figure 111. Profile of boiling pit facilities.

Figure 112. Photograph of experimental boiling pits.

The initial step in the experiment was to build a small fire in the hearth to promote immediate ignition of the fuel. In the case of chip fuel, it was always necessary to begin the burning process with some kindling, unless of course the chips were added to an already smouldering chip fire. Some of the fuel was added to the fire, and the stone was placed on top with the remaining fuel heaped over the stone (see Figure 110). In some instances, a few pieces of fuel would not fit on the pile, and some slipped off the pyre during the course of the experiment. These pieces were added to, or pushed back into, the main fuel pile as the experiment proceeded. The objective was to ensure that all the fuel was consumed, so that the measure of fuel used and heat imparted would be an honest appraisal of the relative heating efficiency of the fuel types.

Once the hearth had been fueled and the stone added, a thermocouple was inserted in the middle of the fire approximately 5 cm above the base of the hearth. Temperature recordings were made at 5, 10, 15 and 20 minute intervals, by which time most of the fuel had been consumed. The stone was then removed from the hearth with a shovel and placed in a pile adjacent to the boiling pit. A wind screen was placed around this pile and a thermocouple was inserted between the hot rocks and allowed to heat for one minute before the surface temperature of the rock was recorded. The rock was then placed in the boiling pit (see Figure 109). Two thermocouples were inserted into the pit. The first probe was mounted on a small block of wood which floated and recorded the pit's temperature just below the water surface. The other probe was placed in the bottom of the pit to measure temperature change in the immediate vicinity of the boiling stones. Temperature recordings were made at 5, 10, 20 and 30 minute intervals. The rock was removed at the end of 30 minutes and sorted into discard and recyclable fragments. Qualitative observations were made with respect to the kind and degree of fragmentation evident on the stone and which shapes of stone seemed more resistant to fracture. Each experimental run required a total of one and a half hours to complete. All the experiments were completed over the course of three days.

Hypothesis testing

A number of questions regarding fuel types, properties of boiling stones and the design of boiling pits prompted the experiments reported herein. These formed a suite of hypotheses to be tested during the course of the experimental programme. The two types of hearth used were designed to evaluate the effect of wind on fuel consumption and heat production.

Given the incessant winds at Head-Smashed-In, it seemed reasonable to predict that a pit hearth would tend to conserve fuel in comparison to a more exposed surface facility. Using the same line of reasoning, it seemed probable that the pit hearth shape would tend to concentrate the heat and result in more of the heat being transmitted to the stone rather than being dispersed by the winds circulating around a surface hearth. The fanning effect of the wind on a surface hearth might tend to produce higher temperatures, but this would be a trade off because fuel consumption would be much more rapid.

We assumed that the use of bison chip fuel was mandatory at Head-Smashed-In, given the scarcity of local wood fuel. However, this did not preclude the long range gathering of wood fuels. The experiments were undertaken with a somewhat skeptical view of how practicable bison chips would be as a heat source. For example, we predicted that the heat derived from chip fires would not approach that provided by wood fuel and that large numbers of chips would be required to produce equivalent amounts of hot rock (cf. Holland 1984).

Insofar as the hearth characteristics were concerned, it seemed reasonable to predict that the chip fuel would leave the least evidence of subsurface heat discolouration and would leave no charcoal residue. Conversely, it was felt that the wood fired surface hearth would leave a much deeper hearth stain than the chip fuel and, therefore, would be more readily recognized archaeologically than the chip fuel pit hearth. It was also predicted that chip and wood fuel would not be used for the same tasks, particularly as the chip fuel is known to smoke heavily and would require more free oxygen than a wood fire. We anticipated that the chip fuel would prove to be an inferior fuel to wood and that only its ready availability mitigated the use of an inferior fuel.

The boiling stone varieties posed several questions, all related to the single query of why a locally abundant source of stone was largely ignored and much time and effort directed toward importing the cobble material. This clearly suggested that some properties of sandstone make it unsuitable as a boiling stone material. Paramount among these may have been the grit particles imparted to cooking pits when using sandstone. The shape of the sandstone rock may have made it unsuitable as a boiling stone given its propensity to break into irregularly shaped slabs that may have taken up too much space in the boiling pit. Some properties of sandstone may have made it difficult to recycle. Sandstone's porous structure absorbs much more water than the cobble stone, requiring prolonged reheating to drive off the water and thereby using up excessive amounts of fuel and generally impeding the progress of boiling pit processing.

Two varieties of boiling pit were employed to assess the effect of pit morphology and surface exposure on the heating and cooling of the pit contents. It was hypothesized that the deep, narrow mouthed pit would retain more heat than the shallow pit which, because of its increased surface area, would cool more rapidly. This suggested that the shallow pit might make a more efficient grease rendering pit, while the deep pit would be better suited for cooking meat portions.

RESULTS

This section provides the detailed findings of the experiments and presents the qualitative and quantitative reseach results. A discussion of the significance of the findings follows. It is cautioned once again that these results are preliminary and based upon a limited number of experimental trials. Further experiments are planned and those results will be combined with the findings reported herein to provide a more comprehensive evaluation of the problems addressed by this research.

Fuels

A total of ten experimental heating trials were completed, four of which were bison chip fires. The average temperature of the fuels over the course of the 20 minute experiments is summarized in Figure 113. It is evident that the bison chip fuel provided ample heat and maintained that high heat throughout the course of the experiments. These results are somewhat at odds with our impressions of these fuels, for it appeared at the time that the wood fires released greater amounts of heat than was

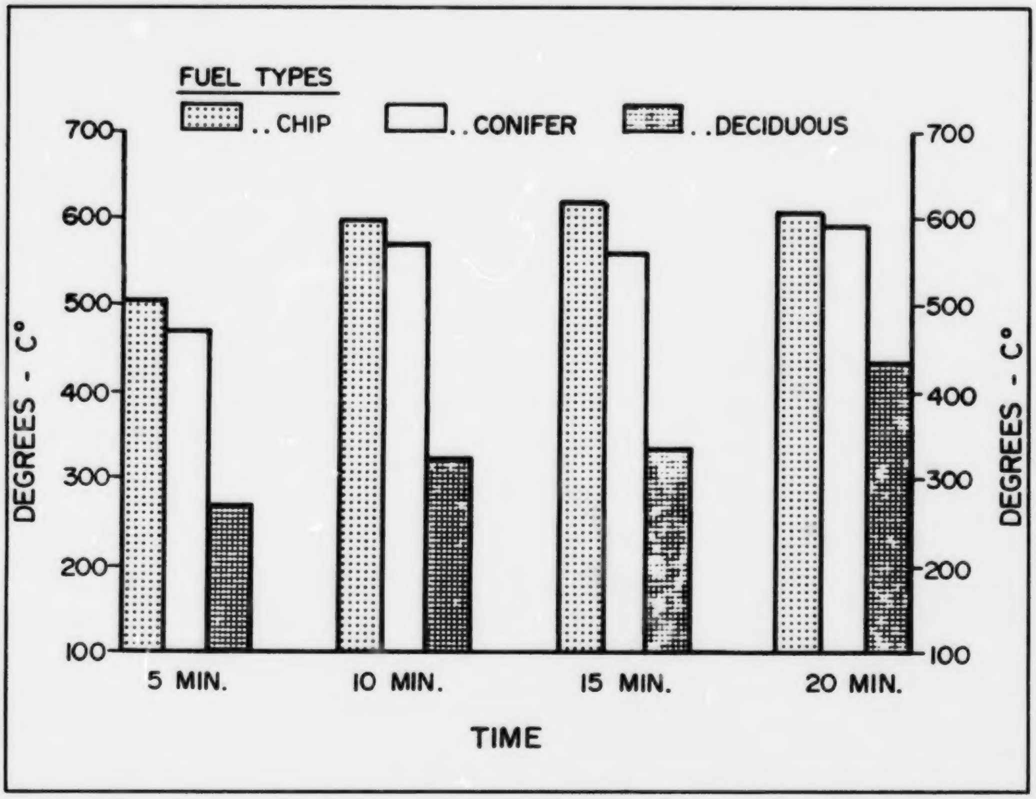


Figure 113. Average temperature of three fuel varieties.

the case for chip fuel. During the course of the experiment, it was impossible to place one's hand in close proximity to the wood fire, while in the case of the chip fire, it was possible to get quite close (30 cm) without discomfort. This accords well with the ethnohistoric observations of the minimal heat derived from chip fires (Cowie 1913:208), and the use of rock-ringed and rock-lined hearths when using chip fuel (Wilson 1924:268). Presumably, the rock absorbed some of the heat and provided a slow release of this heat for cooking and heating purposes. The question remains, however, as to how the measured heat from chip fuel can be equal to wood fuel and yet provide so little radiant heat.

The answer appears to lie in the way in which chips burn. Because the chips are composed entirely of vegetal matter, they burn slowly and completely with a fine residue composed entirely of ash. If not disturbed, this ash retains the original shape of the chip and appears to act as an insulating jacket between the internal (i.e., burning) and exterior (i.e., non-burning) surface of the chip. Unlike the wood fuel, which radiates a greater percentage of its heat to the atmosphere, chip fuel retains the heat it produces. Anyone who has maintained a wood fire knows that adding more fuel creates draft, enhancing the flow of oxygen to the fire, thus heightening the flame and amount of heat released. This does not appear to be the case for chip fires (Cowie 1913). Although a fresh breeze is absolutely essential for a successful burn, heaping additional fuel on the fire does not appear to enhance the burning rate or temperature attained. Perhaps the insulating cover of ash from the previously burned chips actually restricts the flow of free oxygen throughout the fuel pile, thus effectively limiting the rate and temperature of the burn.

The fact that a consistent breeze is essential to the success of a chip fire presents some important considerations regarding the use of this fuel. For example, it is highly unlikely that chips would be burned inside habitations where breezes would be slight to nonexistent. When the wind let up during the course of the experiments, the chip fire would take on the characteristics of a smudge, with low heat, excessive amounts of smoke and a very slow burn. The introduction of even a moderate breeze would reverse this situation, promoting flames and a substantial increase in heat production. Based on the qualitative results of this study, the smoke derived from about ten slow burning chips would be sufficient to fill a large tipi structure with smoke in less than ten minutes. In some cases, these indoor chip fires could have been improved by raising the tent flaps to introduce breezes, obviously a practise restricted to milder seasonal conditions, or by the augmentation of the fuel with other combustible materials (cf. Fidler 1792-1793:15). Overall, however, chip fuel is best considered an out-of-doors fuel that was employed only when sufficient supplies of wood were unavailable.

This is not to say that chip fuel is inferior to wood fuel (e.g., Holland 1984), for our experimental results, though few in number, clearly illustrate that chips provide a particularly effective and very efficient means of heating stone. The evaluation of a fuel cannot be reduced to a single criterion for this does not reflect the reality of the situation. Statements pertaining to fuel efficiency must be qualified with respect to the task performed, resources available, environmental conditions involved and the intended duration of the activity. In consideration of these factors, the selection of chips represents the most efficient and best available choice of fuel that could have been made by the occupants of HSI for purposes of heating boiling stones. It should also be noted that stripping and drying of meat, insect control and smoking of hides could also have been facilitated by the burning of chip fuel (Swanton 1911:64) which were, no doubt, important activities at HSI.

Contrary to the ethnographic accounts, lay experiences and scientific evaluations, this study's results pronounce bison chips to be an excellent fuel, but only for specific kinds of applications. Owing to their ample supply, specialized burning characteristics and in the absence of other resources, chips provided the best available fuel at HSI. In the absence of chip fuel, it would have been impossible to process the volume of bison meat and bison by-products that are obviously represented in the camp and processing site deposits. Chips are not universal fuel in the way that wood is conceived, but for specific jobs, locales and events, it can be the optimal fuel.

Hearth Facilities

Too few experimental trials were run to properly evaluate the comparative heating potential of surface and pit hearths, but some qualitative statements can be offered. In the case of chip fires, it was noted that the pit hearth yielded higher temperatures than the surface hearth, but this would require verification by several more trials. The fact that the pit protects and confines some of the heat of the burning fuel would readily explain the higher temperatures observed, and supports one of our earlier stated working hypotheses.

Of more interest for purposes of the assembly of analogs for Head-Smashed-In features are the profiles of the hearths following completion of the experiments. The surface hearths are illustrated in Figure 114, and it is evident that the heat from the wood fires has penetrated much deeper into the subsoil than the chip fires. It is also evident that the wood fueled hearth reveals a more consistent shallow basin-shaped profile with a distinct circular planform.

Figure 114. Profiles of chip surface hearth (upper) and wood surface hearth (lower) after completion of experiments.

The profile of the chip hearth reveals a much shallower extent of heat penetration, more in the form of a rind as opposed to a symmetrical basin. Plan views of the hearth also reveal a patchwork of differential heat penetration suggesting that the insulating effects of the ash residue may be involved in the production of this pattern. Excavations in the camp/processing area of HSI have recorded numerous occurrences of amorphous, shallow hearth stains that could well be the cumulative effects of many years of surface chip fires.

The pit hearth profiles are illustrated in Figure 115 and reveal no significant differences. Both the extent of heat penetration and the clear outlines of the hearths in plan view indicate little variation in the residue left by the different types of fuel when fired within a pit. The supposition of the pit being a better conserver of fuel will have to await verification through further experimentation; however, the impression formed during the experimental trials was that fires in pits lasted longer and could be re-kindled more readily than was the case for surface hearths.

Boiling Stone Varieties

Despite the limitation of a restricted number of trials, a number of qualitative evaluations are offered at this time regarding the properties of the boiling stone material used.

From the outset, it was apparent that the tabular sandstone pieces were much easier to manipulate with a shovel than were the sometimes highly elusive rounded cobbles. No doubt the use of a forked stick with a sling would have simplified the task of moving the round cobbles (see Figure 42), as several slips and unintentional impacts resulted in the premature fracture of many cobble pieces. The sandstone appeared much more resistant to the latter kinds of breakage, and very few of the pieces fractured even after several episodes of cooling and heating. This is thought to be due to the structure of sandstone. Its coarse grained matrix allows for expansion and contraction without risk of failure through splitting. On the other hand, the finer grained cobbles were less forgiving of rapid heating and cooling stresses. The limestone cobbles became quite volatile when heated and were spontaneously reduced to small unusable fragments on several occasions. The shape of the

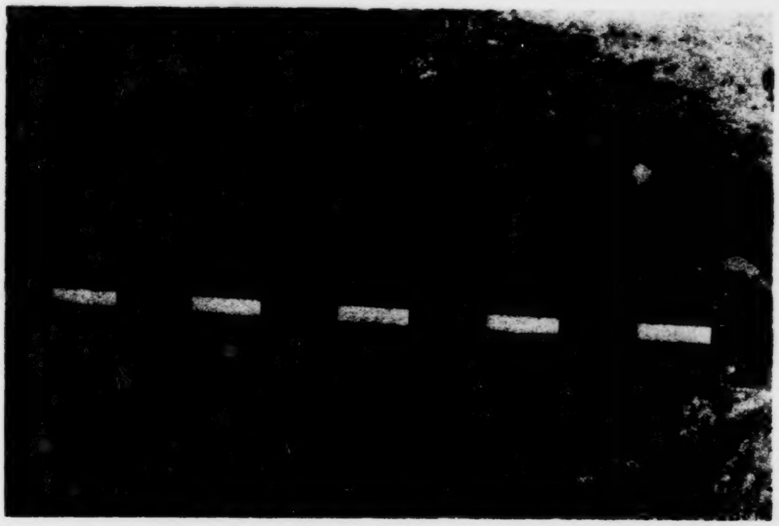


Figure 115. Profiles of chip pit hearth (upper) and wood pit hearth (lower) after completion of experiments.

cobble may have an influence on this failure rate, for it was observed that the more rounded the stone the better its chances of surviving several heatings and coolings without significant cracking. Presumably, rounded shapes are better able to disperse the stresses associated with boiling stone technology.

Sandstone yielded the highest rock surface temperatures, ranging between 223°C and 475°C with a mean of 311.5°C. Whole cobble materials revealed heat ranges from 222°C to 389°C with a mean of 278.4°C. This temperature variation is probably related to rock structure, with the porous sandstone being able to absorb and disperse heat more rapidly. Although this may appear to be a desirable property at first glance, it is important to remember that while the sandstone can absorb heat more efficiently it also absorbs water and thus requires a much longer drying time than the cobble materials. The porous nature of the local sandstone also contributed a certain amount of grit to the boiling pit, whereas the cobble stone materials were relatively clean. This may have been the overriding consideration in selecting against sandstone rock. Although prehistoric camp life made some contamination of foodstuffs impossible to avoid, an obvious source of undesirable matter could have been avoided by selecting an alternative boiling stone material. This may have been particularly important when rendering bone grease, as opposed to the simple boiling of meat portions, for any grit present in the pit would rapidly be incorporated into the grease and, subsequently, any pemmican manufactured with that grease.

Boiling pit facilities

A total of nine experimental trials were run using two varieties of pit. Preliminary results indicate that the heating characteristics of the two pit facilities are quite distinct. This may have been important prehistorically in determining which kind of pit would be employed for a given type of activity. The temperature curves of the two pit facilities have been averaged for all experimental trials and are presented in Figure 116. In the case of the shallow pit, a wide range of variation was observed between the temperature at the surface of the pit compared with the base of the pit at the five minute interval of the experiment. Later in the experiment, the temperatures begin to coalesce.

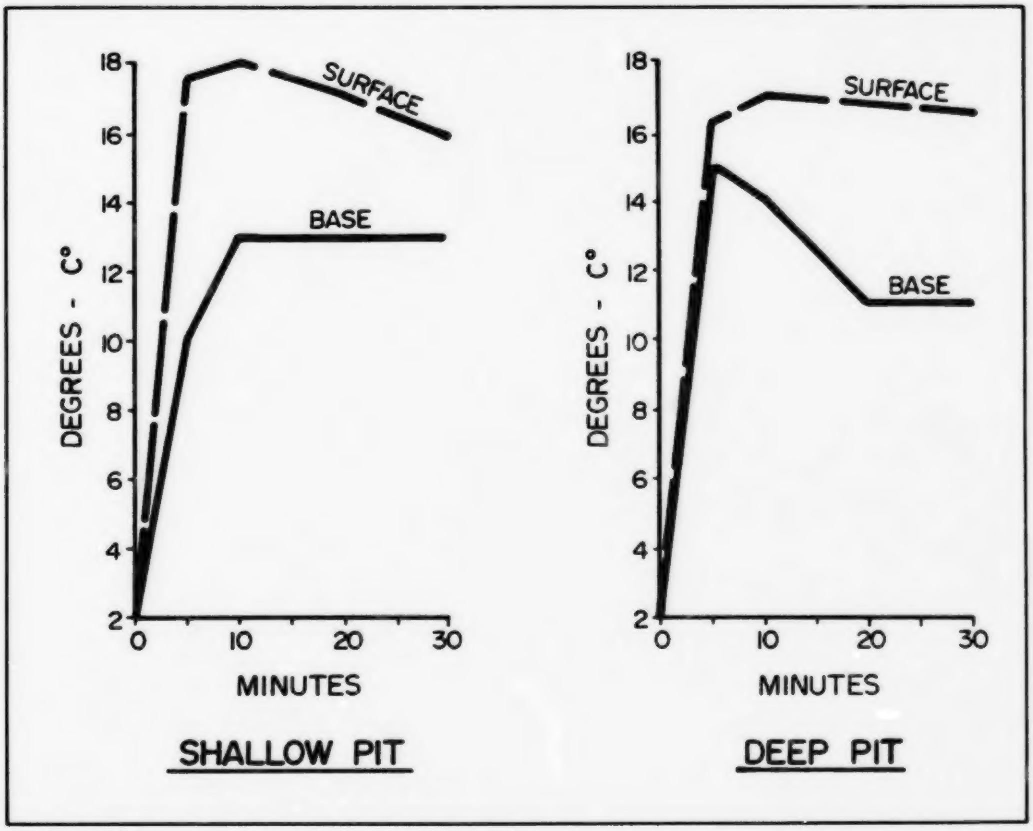


Figure 116. Averaged temperature curves for two varieties of boiling pit.

Comparing these results to the evaluation of the deep pit reveals a contrast. There is a close correspondence of basal and surface temperatures in the early stages and divergence of temperature as the experiment proceeds. The explanation of this pattern resides in the shape of the pits. The wide-bottomed shallow pit permits dispersal of the boiling stones and does not create the concentrated heat evident in the narrow base of the deep pit. While the deep pit heats rapidly, it does present a taller column of water and allows more of the heated liquid to rise to the surface thus yielding the divergence of temperatures. The shallow pit has a much reduced column of water, and the temperatures rapidly form a more uniform curve. Surface cooling of the shallow pit is more rapid than the deep pit, a direct function of the increased surface area involved. It seems plausible that the rapid cooling characteristics associated with the shallow pit surface would make it more suitable for grease rendering, given the fact that grease would need to congeal before it could be removed by skimming. The deep pit would provide a more efficient cooking facility, however, for it retains heat longer because of the smaller surface area exposed.

DISCUSSION

It would be inappropriate to offer firm conclusions at this time based on the small number of experimental trials completed. However, this does not prevent an overview of some of the more notable experimental observations, and brief comparison with the results of other experimental research programmes. Owing to the nature of the data involved, these comparisons are limited to qualitative observations only.

The study results provide the initial basis for assembling analogies that will be used in the interpretation of the HSI processing site residues and features. A major stumbling block in the interpretation of prehistoric plains features and feature residues is the lack of detailed ethnographic accounts of feature usage and morphology (Smith and Cole-Will 1984). It is anticipated that further experiments will be guided, in part, by the morphology of the prehistoric features recorded at the HSI processing site. This inventory now stands in excess of 40 features and will, by virtue of their content and morphology, help to make future experimental programmes more truly replicative in nature, rather than simply observational.

The experimental trials evaluated three types of fuel: bison chips, deciduous wood and coniferous wood. For purposes of developing analogs for the HSI study area, the evaluation of bison chips was of particular importance for it is likely to have been the primary fuel available. The site of the processing and camp area would no doubt have been largely reliant on this fuel. Those camp sites located in the Oldman River valley would have ready access to abundant deciduous wood, as well as coniferous drift wood transported by seasonal floods.

Bison chips proved to be an excellent fuel that provides long lasting and very hot fires. However, there were several conditions that had to be satisfied to ensure successful combustion. It was evident that a steady breeze was the essential condition for burning bison chips, notwithstanding the requirements of well seasoned (dried) chips and wood shavings to start the fire. Local supplies of dried brush immediately available from the slopes of the kill site would have provided sufficient kindling for purposes of igniting the chip fuel.

Previous studies (Holland 1984) indicate that the combustion of chip fuel does not yield equivalent units of heat when compared with wood fuel and that, by and large, chip fuel is inefficient when compared to wood fuel (Holland 1984:164). This equates well with the ethnographic record, where it is noted that wood fuel was much preferred over chips and that chips were only utilized when wood fuel was unavailable. This, in turn, appears to be linked to the seasonal round. When groups were located on the prairie, there appears to have been little choice but to use chip fuel (Dyck 1977).

The implication of these data is that bison chips are an inferior fuel with limited thermal capability. This is at odds with the results of this study. It is true that an equal volume of chip and wood fuel will yield substantially different quantities of heat, but this does not take into consideration the relative costs of obtaining the fuel nor the type of heat derived. The results of this study indicate that chip fuel provides as high, and sometimes higher, temperatures than wood fuel, but that very little of this thermal energy is realized as radiant heat. This would account for the ethnographic descriptions of the inferior heating capabilities of chip fuel and the results of laboratory assessments comparing chips and wood (Holland 1984).

An important consideration when conducting explicitly "scientific" evaluations of aboriginal technologies and materials is that site specific conditions may mitigate in favour of an otherwise deficient material. It is believed that chip fuel was used extensively at HSI because of its ready availability and ease of procurement, with thermal efficiency being relatively unimportant. The burning characteristics peculiar to chip fuel may, in fact, render it a more cost efficient fuel for specific applications (i.e., heating boiling stones) than would be the case with wood fuel. We suspect, however, that the relative thermal efficiency of chip fuel compared with wood fuel was never really the prime consideration when aboriginal peoples were processing bison at Head-Smashed-In. This does not negate the observations derived from more rigorous evaluations of the thermal capabilities of aboriginal fuels (cf.

Holland 1984). However, such studies can, at times, lose sight of the more practical questions in pursuit of trivial side issues such as the stacking characteristics of bison chips.

The evaluation of the two varieties of hearth facility indicates that pit hearths conserve heat better than surface hearths and promote deeper oxidization of the subsoil. The oxidization pattern resultant from surface hearths fueled with bison chips consists of a shallow shapeless configuration of differential heating. This compares favourably with the majority of the hearth features from the HSI camp and processing area. Basin-shaped hearth depressions do occur, but they are in a minority, despite their thermal efficiency.

In the final analysis, it is probably the compact prairie soils and abundance of chip fuel that promoted the use of short term surface hearths. This would also explain the absence of large charcoal fragments at HSI, where brush and twig sized fragments are noted to occur most commonly. As there is no charcoal residue from chip fires, the charcoal must originate from local brush used to light the chip fuel or, alternatively, from the occasional use of wood fires. It may also be the case that seasonal constraints are controlling the types of hearths employed (Dyck 1977) as well as the particular purpose for which the hearth was employed.

Evaluation of the two varieties of boiling stone was of particular importance to the interpretation of Head-Smashed-In processing site deposits. Despite the abundance of locally available sandstone, most of the boiling stone used at the site was imported. Our experiments indicate that this has nothing to do with the heating characteristics of the two stones, for it was found that the sandstone yielded higher temperatures and was less susceptible to sudden fracture upon cooling (cf. House and Smith 1975). However, it was apparent that the sandstone absorbed a good deal of water and required a longer drying time than limestones and quartzites and that the sandstone always imparted some grit to the boilng pit. This may be unimportant considering the contamination resulting from blowing sediments, grit adhering to meat portions and retrieving sticks, and a general lack of concern for ambient dust and grit that would prevail in most aboriginal camp situations. While many of these sources of contamination can not be easily eliminated, the grit from sandstone boiling stones is readily identifiable and corrected by the use of alternative materials. The time and effort required to transport suitable boiling stone materials to HSI was considerable and suggests that both water absorption and grit residues discouraged the use of local sandstone. The possibility exists that very little of the fire reddened sandstone at HSI was used as boiling stone material, for sandstone was often used in roasting food remains in both pits and surface hearths (Munson 1984; Smith and Cole-Will 1984), and it may have been these activities which produced most of the thermally altered sandstone recovered at HSI.

Comparisons between the two varieties of boiling pit employed were presented earlier, and little more can be said until additional comparative studies are completed. Future experiments will include pits lined with fresh buffalo hides, as this may help to conserve the heat better than plastic film and prove more resistant to the sharp-edged fire broken rock fragments.

CHAPTER SIX

A PRELIMINARY ASSESSMENT OF THE HEAD-SMASHED-IN BUFFALO JUMP DRIVE LANE CAIRN COMPLEX

INTRODUCTION

During the 1984 field season, a brief and preliminary study of part of the drive lane system at HSI was initiated. This study, as with much of our 1984 work, was motivated by a need to enhance our knowledge of aspects of HSI which have heretofore received scant professional attention. This is especially true for site features such as the rock cairn drive lanes which will form an important component of the on-site interpretive programme.

Head-Smashed-In Buffalo Jump consists of a site complex which includes a large (c. 40 km^2) gathering basin for collecting bison, an extensive and elaborate drive lane system, and a kill and processing area. The gathering basin and associated drive lanes comprise the largest and most complex system known anywhere in the plains. Reeves (1978, 1983b) outlined the geographic parameters of the gathering basin and has roughly indicated the position of most of the known rock cairn alignments. A more detailed mapping and recording programme designed to accurately locate the known as well as any previously unrecorded rock cairns in the HSI basin on topographic maps and aerial photographs is currently being completed by Reeves. The project is being done under contract to Alberta Culture and, as of this writing, the results of the project are not available. Within the next few years, we envision studies of the drive lane system, once fully recorded, to be a major focus of the analysis of how the bison driving system operated. The HSI drive lane complex is also presently being studied by M. Rollans of the University of Alberta whose Master's thesis will attempt to explain the nature and function of the lanes and cairns.

The 1984 research design called for the brief examination of small segments of two separate rock cairn alignments. The focus of these studies was to excavate the soil matrix away from the cairn rocks. In addition, we examined a total of 50 individual cairns and, without excavating, recorded the type and size of the exposed rock. In all these studies, our interest was in the shape, size, number and types of rocks in the cairns and any details on method of construction. The goal of this work was to gain additional information on the individual rock cairns which make up the HSI cairn complex and, if warranted, to venture some preliminary observations on the function of the cairn system. The description of the areas selected for study, the kind of work conducted, and the results of the study are discussed below.

METHODOLOGY

The HSI gathering basin is littered with numerous rock alignments, most of which are presumed to have functioned in driving bison towards the kill site. We decided to excavate individual cairns in two separate but associated rock alignments which are close to the kill site. The setting of these two lanes is such that there is no doubt about their role in the communal hunt system. We say this because there are other linear alignments of stone in the gathering basin whose physical setting is such that their role in a communal bison drive must be questioned. Thus, one factor in our selection of cairns to study was that of clear association with the kill. Other factors included ease of access and landowner permission. Finally, the two rock alignments chosen differ substantially in their surface appearance, as described below. We intentionally wanted to examine rock cairns which exhibited a degree of formal distinction.

The two rock alignments selected for evaluation are both part of what Reeves (1978) has termed the south pass. This is a swale or channel across the ridge of the Porcupine Hills which opens into the east side of the gathering basin and constricts as it leads east towards the kill site (see Figure 2). The south pass probably represents the most important route for moving bison from the collecting area to the jump-off. The south pass is endowed with numerous rock cairn alignments which are oriented in a variety of directions and which traverse a range of topographic features. It is beyond the scope of this report to attempt a full analysis of these drive lanes, for they have yet to be accurately mapped. We selected two lines of cairns found in the south pass for study. One line is situated on the north side of the south pass channel. It runs roughly east to west paralleling the north wall of the channel and extends for at least 2 km. The west end of the alignment has only been followed a few hundred metres west of its intersection with the dirt trail which parallels the ridge on which the jump-off is situated. The east end can be followed past the cattle dugout in the bottom of the pass channel into a wind deflated area to the crest of the ridge before the cairns disappear (see Figure 2). From here, we believe that the cairns which continue on the downhill side of the ridge leading toward the jump-off are probably still intact but have been covered over by blowing soil. The strong westerly winds have probably aided in keeping the cairns on the uphill (west) side of the ridge exposed but have in turn caused drifting over of the rock piles on the downslope (east) side of the ridge. This drive lane along the north wall of the south pass channel was apparently the main line of confinement for keeping the bison from breaking out of the north side of the channel. The south side of the channel is also guarded by drive lanes, but these are more complex, with several diagonal lines rather than one continuous parallel line as found on the north side.

We will refer to the line of cairns on the north side of the south pass as drive lane 1. Several hundred individual rock cairns can be observed in this lane (we have not made an exact count). The spacing of the cairns is generally quite regular, with most cairns placed between 4 and 5 m apart. Rarely, cairns are as close as 2 m or as far as 10 m apart. The individual rock piles which make up drive lane 1 are quite distinct, with the tops of several rocks clearly visible on the surface at each cairn location (Figure 117). Most cairns appear largely undisturbed in that surface rocks are clustered tightly together. However, if one assumes that the rocks at each cairn were originally piled on top of each other, then slumping has occurred since very few cairns now display any piled rocks. This standard image of a rock cairn as piles of stones may be inappropriate. It seems equally plausible that the rock clusters visible today, consisting of a base - but not a pile - of rocks, may in fact reflect the original form of these structures and that slumping of the rocks has not occurred. This will be discussed further after our results are presented.

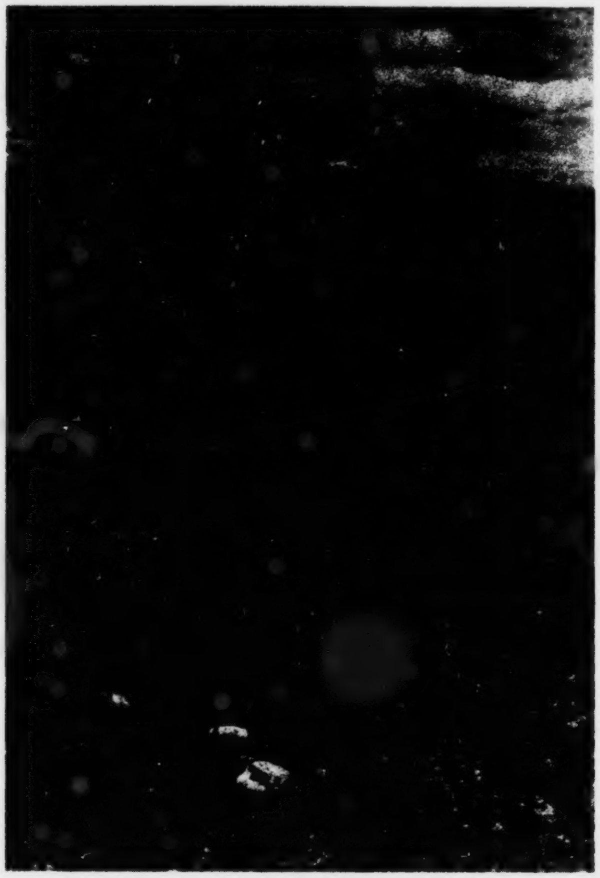


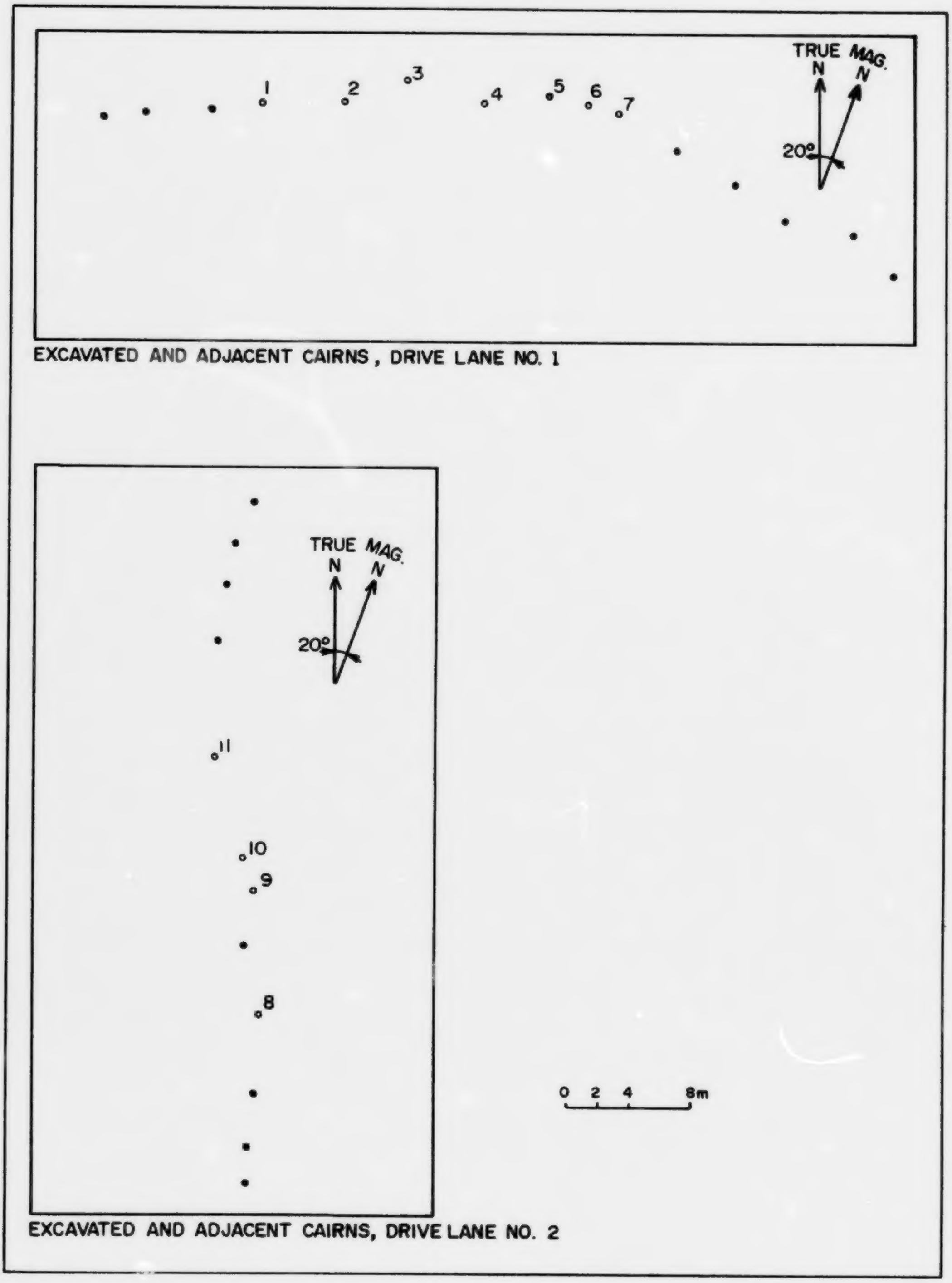
Figure 117. Looking west along drive lane 1 (cairns head towards vehicle parked on trail).

The second drive lane (2) selected for excavation is also part of the south pass confinement system (see Figure 2). This line is a shorter and more obscure row of cairns. It is situated at what is essentially the end of the south pass channel at the crest of the ridge before the downhill run to the jump-off. The channel loses its topographic definition at this point, and it becomes necessary to make a major turn to the northeast to angle the herds towards the jump-off (see Figure 2). A raised point of land which curves around towards the northeast helps form a natural border to the north side of the desired direction of movement, but the south side opens into a broad, flat spread of land to the east of the cattle dugout which would permit easy escape of the animals. The second drive lane studied is a lane which we believe was constructed to help turn the herds to the northeast and towards the jump-off.

Drive lane 2 can only be traced for a distance of about 300 m. The line runs close to north-south, originating at the base of the slope which leads to the bedrock knoll where the main petroglyph site is situated (see Chapter 7). The cairns at this south end of the line seem to simply disappear. It may be that the high bedrock knoll acted as a barrier to the animals, with the cairns picking up as the knoll tapers off. The north end of the cairns also seems to simply stop without any obvious explanation. Again, this may reflect the fact that cairns placed to the east side of the ridge crest have drifted over.

The individual cairns of drive lane 2 appear quite different from those of drive lane 1. The former are represented more by noticeable humps of soil in contrast to the clear rock clusters of the latter. Cairns of drive lane 2 are more obscure and can only be detected by careful scrutiny of the landscape. The few exceptions to this are cairns which employed large glacial erratics which are still clearly visible. The general impression at the start of our study was that the rock cairns for drive lane 2 are more completely buried under a cap of soil and vegetation than are the cairns of drive lane 1. We suspected that this might reflect differential age of the two lanes, or perhaps differential construction techniques or materials. These obvious differences between the two lanes (as well as other factors mentioned above) led us to select these two lanes for detailed study.

Each set of drive lanes was recorded on aerial photographs and a 1:10,000 topographic map, although this was restricted to only the portions of the lanes being examined. In addition, simple sketch maps were made with a Brunton and chain of the rock cairns in the immediate study area (Figure 118). The main work consisted of excavating the soil surrounding the cairn rocks. As our purpose here was to expose all rocks associated with the cairns, there was no need to establish a grid system. Instead, soil and vegetation was troweled and brushed away from the cairn rocks and stockpiled to one side. A 1/4 inch mesh screen was brought to the excavations but was found to be largely unnecessary as the small amount of dirt removed was easily visually inspected. Troweling


EXCAVATED AND ADJACENT CAIRNS, DRIVE LANE NO. 1

EXCAVATED AND ADJACENT CAIRNS, DRIVE LANE NO. 2

TRUE N
MAG. N
20°
1
2
3
4
5
6
7
TRUE N
MAG. N
20°
11
10
9
8
0 2 4 8m

Figure 118. Map of rock cairns in drive lanes 1 and 2 (open symbols denote excavated cairns).

continued until we were satisfied that no additional rocks remained to be exposed, vertically or horizontally. Vertically, no excavations needed to continue beyond 10 cm below surface. Horizontally, most cairns were fully mapped with a 1 m^2 mapping grid. A few cairns required this grid to be extended in one direction to accommodate one or two rocks which lay outside the 1 m^2 grid. Plan drawings and photographs of the excavated cairns were completed. Initially, we also intended to draw a profile sketch of each exposed cairn, but upon finding that none extended below 10 cm below surface we decided to draw only one cairn profile. This profile was simply a side view of the cairn, not a cross-section. We did not move or disturb any of the cairn rocks. At the completion of the work, the excavated earth was placed back around the cairns.

The final part of our 1984 drive lane study consisted of a surface survey of fifty cairns located in the south pass area (see Figure 2). Thirty-five of these cairns are part of what has been called drive lane 1 on the north side of the south pass. These are different cairns than those which were excavated in drive lane 1. The remaining fifteen cairns were associated with drive lanes at the east end and on the south side of the south pass. Ten of these are part of drive lane 2 but, again, are different cairns than those excavated.

The purpose of examining a larger sample of fifty cairns was to gather more representative data than could be obtained from the small excavated sample of cairns. Information recorded for the fifty cairns included number of rocks, lithology of the rocks, size of rocks, shape of cairn measured in two horizontal dimensions, and compass orientation of the long axis of those cairns which displayed an asymmetrical shape. As the results of this surface survey of fifty cairns bears directly on the results of the cairn excavation project, we will integrate the data from both studies in the following section.

RESULTS

Seven cairns were excavated along drive lane 1 and four along drive lane 2. The selection of which cairns to excavate was largely arbitrary as there is little apparent difference between the surface appearance within each drive lane. We did intentionally excavate a continuous sequence of cairns at each of the two sites. This was to provide an uninterrupted view of several exposed cairns.

Prior to excavation, the cairns in drive lane 1 were characterized by a cluster of five to ten on-surface or partially buried rocks (Figure 119). Also, there was a slight rise or hump to the ground surface at each cairn location. We had anticipated that this was due to the presence of additional cairn rocks buried below the ground surface. For the most part, this proved to be incorrect. While in every case some additional rocks were encountered below the surface, mostly these were either small rocks which may have been locally present before cairn construction or broken fragments of the surface rocks. The latter was especially true of

Figure 119. Unexcavated cairn in drive lane 1.

the sandstone rocks used in cairn construction and less so of the harder limestone and quartzite cobbles. In no case did we encounter additional rocks (c. 10 cm diameter) which had not been at least partially visible on the ground surface prior to excavation.

The soil matrix at the cairns in drive lane 1 was a sandy-silt texture, presumably loess, with a thin scattering of sandstone and quartzite pebbles. These rocks incorporated into the loess are probably glacial outwash gravels except for the Paskapoo sandstone fragments which are derived from the local bedrock. The sod layer here, as over most of the site area, is seldom more than a few centimetres thick. The vegetation along the drive lane is primarily the unbroken grassland community typical of the entire gathering basin and consisting mainly of rough fescue. There are no shrubs or trees anywhere along the line, but some are found in the bottom of the south pass channel at its east end where the cattle dugout is situated. We noted that some of the cairns tended to promote growth of grass species which differed somewhat from the surrounding prairie. This presumably is a result of the slight microenvironmental change caused by the cluster of rocks (i.e., changes in water retention, solar radiation, soil stability, etc.). We have not yet identified the plant species which tend to occur in association with the cairns. This association may prove useful, however, in tracing the path of cairns over the east side of the ridge where we believe drifting soil has obscured the rock features.

Plan views of the seven excavated cairns in drive lane 1 and a profile view of one cairn (2) are presented in Figures 120 and 121. When exposed, the cairns appeared to be composed of approximately 12 to 25 rocks. Precise counting was hampered by: (1) uncertainty over whether many of the small rocks laying around and amidst the larger rocks were actually part of the cairn or were simply natural; and, (2) the fact that cairn rocks were sometimes fragmented resulting in multiple counts being recorded for what was originally one rock. With regard to the former concern, it is our opinion that any of the small rocks located around the cairn are in fact natural. This is based on our examination of the surrounding landscape where agricultural and animal disturbances revealed a stoney soil below the grass sod.

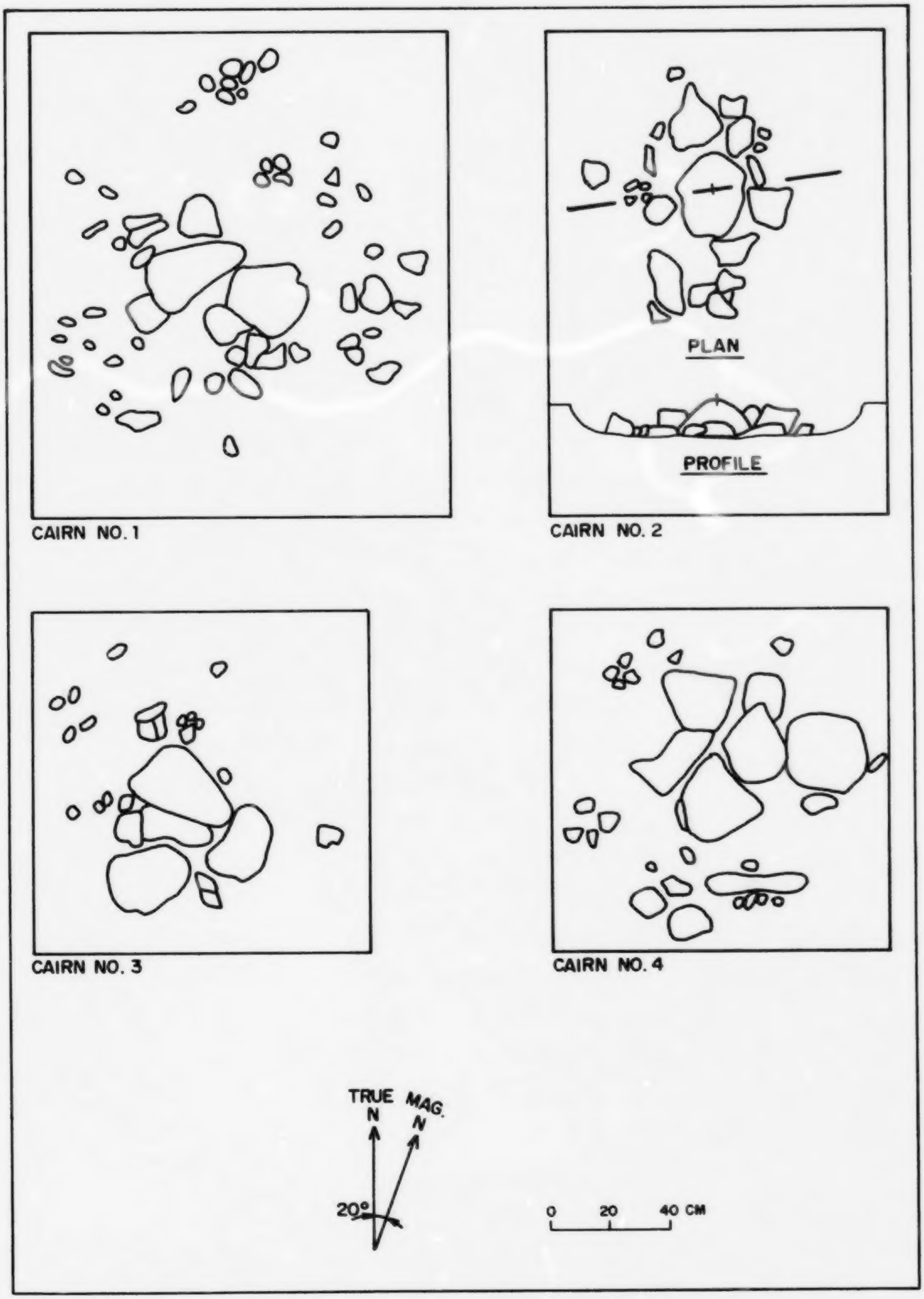

CAIRN NO. 1
PLAN
PROFILE
CAIRN NO. 2
CAIRN NO. 3
CAIRN NO. 4
TRUE N
MAG. N
20°
0
20
40 CM

Figure 120. Plan view of excavated cairns 1-4, drive lane 1.

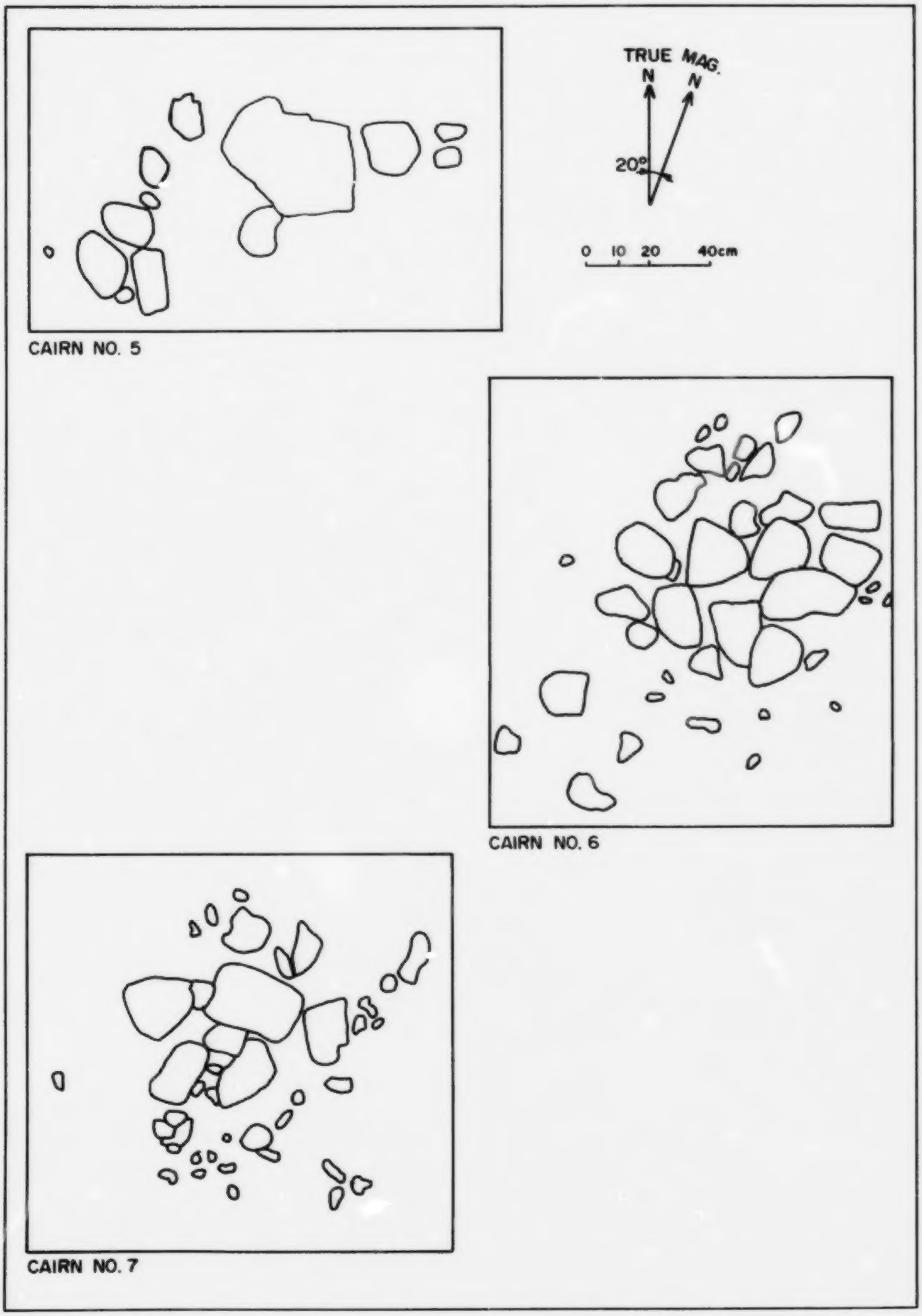

TRUE N
MAG. N
20°
0 10 20 40cm
CAIRN NO. 5
CAIRN NO. 6
CAIRN NO. 7

Figure 121. Plan view of excavated cairns 5-7, drive lane 1.

Omitting the peripheral small rocks, all cairns were characterized by a central cluster of large stones measuring approximately 0.7 x 0.9 m, thus occupying a surface area of some 0.65 m^2. Cairn 5 is the exception in that it is spread over a distance of 1.3 m on one axis, possibly reflecting some disturbance since the time of abandonment. The long axis on all seven cairns was roughly north-south. The cairns are all situated on the side wall of the south pass channel where the ground surface slopes some 10-15° in a north-south direction. This slope may account for the orientation of the long axes of the cairns, as over time, slumping rocks would tend to gravitate downslope in a southward direction.

Once the cairns were exposed, the lithology of the rocks was identified. A total of six rock types were identified in the cairns: Paskapoo sandstone, other sandstone, quartzite, quartzite conglomerate, granite, and limestone. Table 30 gives the number and percent of the rocks in the seven excavated cairns of drive lane 1. Paskapoo sandstone, the local bedrock, comprises the majority of cairn rocks (57.8%), followed by quartzite (19.5%), limestone (13.3%), other sandstone (7%) and finally, tiny amounts of the remaining two rock types. These results are somewhat at odds with our lithological analysis of fifty cairns chosen from drive lanes 1 and 2 and two separate lanes on the south side of the south pass channel. Examining only surface-visible rocks, this study showed quartzite to be the overwhelming favourite, comprising 66% of all rocks in the study cairns. Paskapoo sandstone contributed 16.6% of the total rocks, other sandstone 7.3%, and limestone only 1.0% (Figure 122). These figures suggest that the high percentage of Paskapoo sandstone in cairns 1-7 in drive lane 1 is the result of local availability of this rock type.

Cairns 1-7 in drive lane 1 are situated just east of a small gulley which runs to the north wall of the south pass channel. In the bottom of this gulley near where it joins the channel are a series of bedrock boulders and outcrop exposures. This is in contrast to much of the drive lane which crosses rolling and sloping prairie generally void of bedrock exposures. We suspect that the high percentage of Paskapoo rocks in cairns 1-7 reflects the proximity of these cairns to the bedrock in the gulley. Also, it should be remembered than the sandstone pieces fragment much more easily that the hard, sound quartzite cobbles, and in arriving

Table 30. Lithology of rocks in drive lane 1 cairns.

Cairn #	Paskapoo Sandstone	Other Sandstone	Quartzite	Conglom. Quartzite	Granite	Limestone	Total
1	18	1	2	1			22
2	3		3			17	23
3	11		5				16
4	13				2		15
5	4	3	3				10
6	19	2	7				28
7	6	3	5				14
TOTAL #/%	74/57.8%	9/7%	25/19.5%	1/0.8%	2/1.6%	17/13.3%	128/100.0%

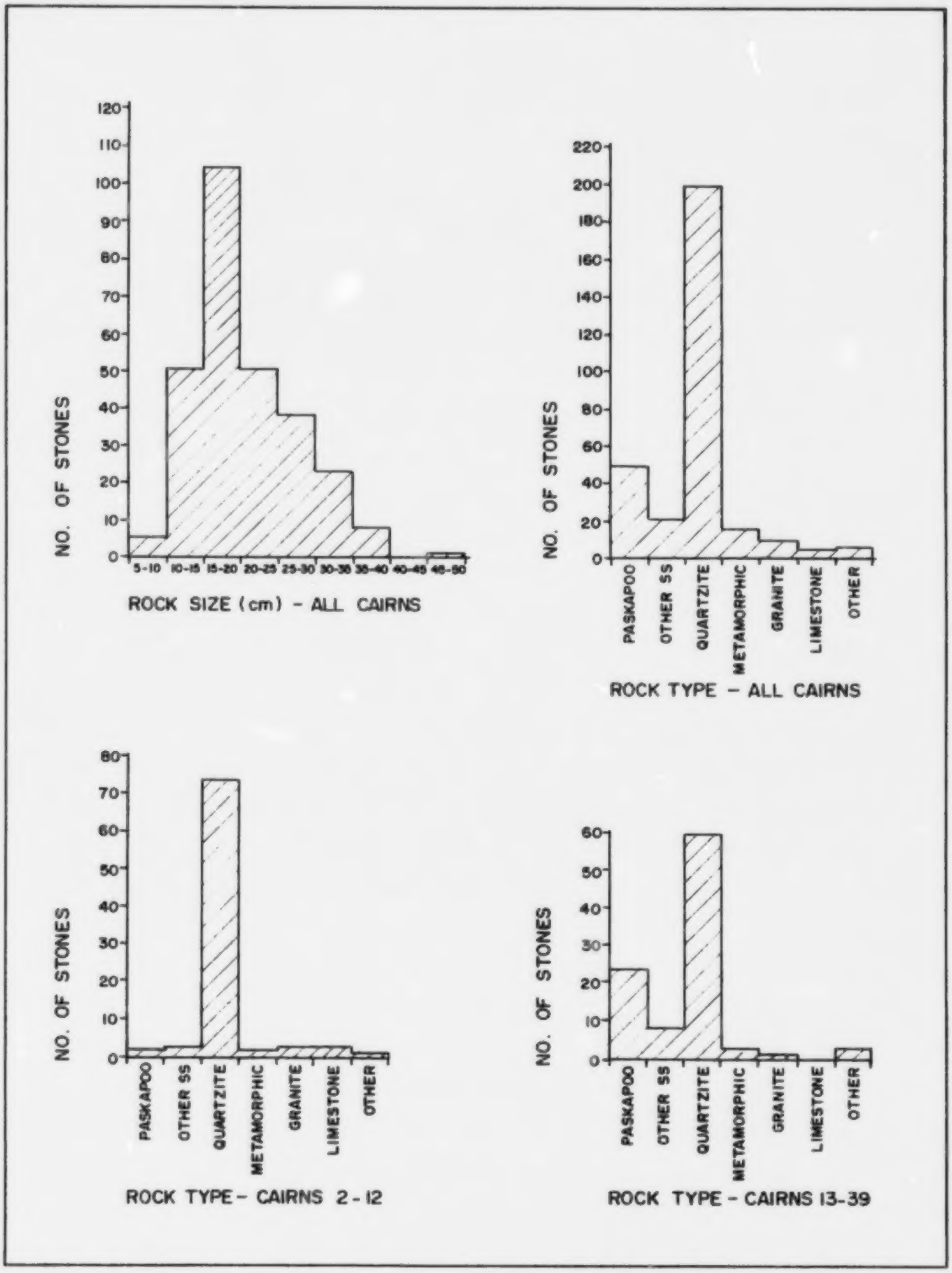


Figure 122. Lithological characteristics of 50 surface surveyed cairns.

at the numbers of rock types in the excavated cairns all fragments were counted. The surface survey of fifty cairns counted only the large surface rocks and would have missed many of the buried fragments. Thus, the importance of Paskapoo sandstone may tend to be over emphasized in the excavated sample of cairns.

This indication of regional variation in cairn lithology is further supported by data gathered from our wide ranging surface survey. For example, examination of twelve cairns along the west end of drive lane 1 revealed that 83.9% of the cairn rocks were quartzite vs. 2.3% Paskapoo sandstone. Several hundred metres to the east, close to the excavated cairns, a series of seventeen cairns were studied and produced figures of 61.4% and 24% for quartzite and Paskapoo sandstone, respectively. We believe this spatial variation in cairn lithology can be attributed to variation in the local availability of specific rock types. Quartzite rocks are scattered more or less evenly across the landscape as a result of previous glacial activity. Other rock types represented in cairn construction are likewise available in the till and outwash materials, including Paskapoo sandstone, but this latter material differs in that it is also available in local concentrations as outcrops. Thus, one would expect the cairns to exhibit the same lithological composition (number and percent of rock types) as are present in the parent population of rocks in the region of the drive lanes. The exception would be where drive lanes come in close proximity to bedrock exposures. At these localities, Paskapoo sandstone should increase in importance in cairn construction. This is in agreement with the limited number of cairns investigated to date.

Given that most cairn rocks are simply collected from the ground surface in the area surrounding where a drive lane is to be constructed, rather than quarried from a few specific sources, one would expect to find a cleared path more or less parallel to the lane representing the zone in which rocks have been gathered. This assumes that people would not want to carry rocks any further than necessary, and that all rocks of appropriate size would be collected regardless of material type. The range of materials represented in the study cairns and the changes in material frequency as cairns move closer to and away from sandstone bedrock outcrops suggests that material type was not an important criterion for cairn construction. More important, we suspect, was rock size.

Our survey of fifty cairns recorded the size of the visible rocks and this information is represented in Figure 122. The measurements reflect the largest dimension of the rocks as measured without disturbing the cairns. Results indicate a strong preference for rocks in the 15-20 cm size range, followed by rocks 10-15 cm and 20-25 cm, and then rocks larger than 25 cm. We examined the ground surface on both sides of the drive lanes in the south pass, especially drive lane 1, to attempt to verify our prediction that a swath of land parallel to the lane would be cleared of rocks suitable for cairn construction. It soon became evident, however, that demonstration of this position requires a rigorous comparison of the ground surface in the immediate vicinity of the lane with that considerably farther away. Acceptable execution of this study would likely require establishing sample grids at varying distances from the drive lanes coupled with systematic counts of visible rocks of suitable size in each sample plot. Such a procedure was beyond the scope of our 1984 project but will be considered in future seasons. For the present, our prediction that a rock collecting area parallel to the drive lanes representing an attempt to minimize human labour in procuring the desired rocks remains untested.

Four rock cairns were excavated in drive lane 2 at the east end of the south pass (Figure 118). As mentioned previously, cairns in this lane appeared quite different from those in drive lane 1 in that few individual rocks were visible on the surface. Lane 2 appeared as a row of earth hummocks rather than rock piles. Although one or two rocks were visible just above the sod at most cairn locations, none of the cairns appeared as clusters of five to ten stones as did nearly every cairn in drive lane 1. Additionally, several of the cairns in lane 2 utilized large (greater than 50 cm) glacial erratic boulders as part of the cairn - a feature very rare in lane 1. Presumably, these large rocks just happened to be naturally placed near the intended cairn location, as it is difficult seeing these being transported very far.

Four earth and rock mounds, numbered 8-11, were excavated in the same manner described above. Three of these, 9-11, were in a row, while 8 was separated from 9 by one unexcavated mound. The mound between 8 and 9 was omitted because it appeared smaller than the other cairns, raising questions as to whether it was in fact a cairn. Cairn 8 is 8 m south of cairn 9, 9 is 2 m south of 10, and 10 is 7 m south of 11.

Soils at this study area were similar to those at the lane 1 locality in that loess was again the primary deposit. Small naturally occurring stones are again common; however, they seemed to occur deeper in the soil profile compared to the lane 1 cairns. In general, the loess deposit appeared thicker in the area of lane 2, perhaps accounting for the deeper gravels. Vegetation at the lane 2 locality was again similar to lane 1, with the notable exception of a very heavy cover of juniper over many of the cairn mounds. One of our excavated cairns (9) was capped with this juniper mat.

Plan views of three cairns are presented in Figure 123. No plan view of cairn 9 was made as no rocks were found within the mound. It may be that 9 was never a cairn. On Figure 118, it was noted that when viewing a larger segment of the drive lane, cairn 9 is unusually close to 10 and the unexcavated cairn to the south. Thus, this mound may have originated by some other means. Perhaps the dense juniper cover was partially responsible for the cairn-like appearance of 9, as this brush could act as a soil trap, eventually developing a mound shape. It is also possible that 9 was in fact a cairn, but not a rock cairn. This will be discussed further below.

As can be seen in Figure 123, the rock component of cairns 8, 10 and 11 differed considerably from that of the cairns in lane 1. Lane 2 cairns are more diffuse; cairn 11 covers a distance of 2 m north-south, assuming all the rocks shown are in fact associated with the cairn. The rocks in cairn 8 are likewise more spread out, with only cairn 10 resembling those found on lane 1. The number of rocks in these cairns is lower than that of lane 1. Cairn 8 contained 16 rocks, 10 contained 14 rocks, and 11 contained 12 rocks, for an average of 14 rocks. In comparison, cairns in lane 1 contained an average of 18 rocks. The difference is even more dramatic when one considers that all rocks found at cairns 8, 10 and 11 were counted, whereas only rocks contained in the central cluster (which we felt could confidently be attributed to a cultural origin) of lane 1 cairns 1-7 were counted. The deeper loess deposit and corresponding deeper burial of natural stones at lane 2

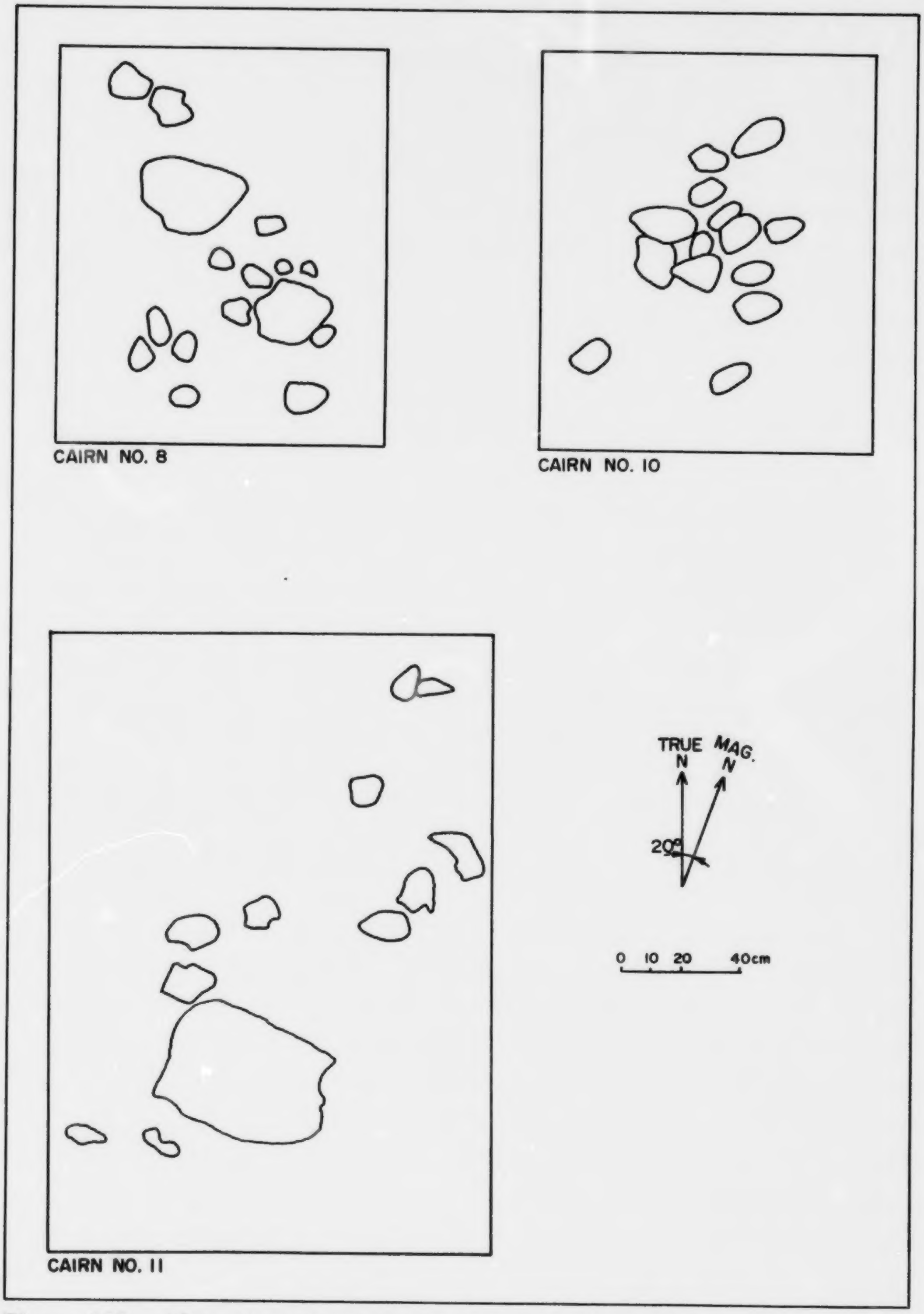

CAIRN NO. 8
CAIRN NO. 10
CAIRN NO. 11
TRUE N
MAG. N
20°
0 10 20 40cm

Figure 123. Plan view of excavated cairns 8, 10, and 11, drive lane 2.

suggests that the rocks uncovered and mapped are more likely to be of cultural origin, uncomplicated by the possible addition of natural stones.

Unfortunately, lithological information was not as carefully recorded for these cairns as it was for those in lane 1. We know that sandstones, quartzites, limestone and metamorphic rocks were present, but we failed to record the exact number or percent. Again, all rocks except Paskapoo sandstone were deposited in the area by glacial processes. Comparing Figures 120 and 121 with 123, it can be seen that the rock size in lane 2 cairns is generally similar to that in lane 1 cairns, although lane 2 cairns tended to have a few rocks larger (the big erratics) than those typically found in lane 1.

Summarizing the results of the lane 2 excavations, before excavation the cairns appeared as distinct humps on the land surface with only a few rocks visible at each cairn. These mounds were noticeably higher than the lane 1 cairns which were flatter but comprised of many more surface rocks. Excavation of lane 2 cairns revealed fewer rocks used in construction when compared with lane 1. Also, the rocks in lane 2 cairns were more dispersed, quite unlike the tight clusters seen in lane 1 cairns. Rock size was fairly similar with a slight tendency towards larger rocks in lane 2. Rock lithologies could not be compared.

DISCUSSION AND OBSERVATIONS

As indicated above, the formal differences between the cairns in lanes 1 and 2 motivated their selection for detailed excavation. The observed surficial differences were substantiated by the results of the excavations. That is, lane 1 cairns were shown to be small piles or platforms of rocks laid on the prairie surface, whereas lane 2 cairns appeared to be small mounds of earth to which a few rocks had been added. If this assessment is correct, it suggests that two techniques of cairn construction may be represented. As will be cited below, the ethnohistoric literature regarding drive lane cairns makes repeated mention of the use of sod and earth to create a cairn structure. Drive lane 2 cairns may well represent cairns made with these materials. There is no evidence for the use of sod or earth in the construction of cairns in drive lane 1.

Caution should be exercised, however, in concluding that different cairn construction techniques and materials can be substantiated based upon our study results. The slight difference in the environmental setting of lanes 1 and 2 could also account for the apparent differences. Soil accumulation and deflation, soil moisture, vegetation cover, aspect, slope and other factors may vary slightly between the two lanes and may play a role in the appearance and composition of the cairns. Similarly, old lanes may have been "robbed" of supply material for a new, nearby lane as continued use of the jump revealed weaknesses in the existing cairn system. One speculation advanced herein is that a core set of lanes was originally constructed and that new lanes were added over time, especially to the west end of the gathering basin and in the small, remote tributary valleys of the basin, to permit gathering and driving of more animals from more locations.

All the above factors would likely contribute to a noticeable difference in the present appearance of the drive lane cairns. Old unused cairns may appear more scattered, as the rocks have had more time to slump or to be kicked around by bison and cattle. Old cairns may also be more deeply buried than newer cairns, depending on the local depositional conditions. Lichen growth on the surface of the rocks may differ substantially between the older and newer cairns. Drive lanes robbed to form new lanes may now show up as clusters of fragments of the original rocks and other small rocks which were considered too small to bother transporting to the new lane. Also, robbed lanes may be evident in the form of small mounds of earth marking where soil accumulated around the original cairn. Perhaps the vegetation change which we noted above was occasionally associated with rock cairns. Finally, robbed lanes should always be found in close proximity to another lane (c. 100 m), as the widespread distribution of naturally occurring, suitable rocks would have made it inefficient to cover great distances to rob an old lane.

An equally important consideration in assessing observable differences between drive lanes is the material used in construction. So far, we have only mentioned rocks as drive lane cairn material. This is because of the obvious importance of this material given the thousands of rock cairns known to exist at HSI. Similarly, most if not all of the documented plains bison kill sites mention only rock cairn drive lanes when any drive lanes are present (cf. Brumley 1976; Frison 1967, 1970; Frison, Wilson and Walker 1978; Reher and Frison 1980). Yet, it is well known from ethnohistoric records of bison pounds and jumps that other materials were used in the construction of drive lanes, the most common being bison chips, brush and heaped up mounds of earth and sod (see Verbicky-Todd 1984 for an excellent review of bison drive lanes). Indeed, of the numerous historic eyewitness accounts of bison pounds and jumps we have yet to encounter a single reference documenting the use of rock cairns; all historic accounts mention only the materials listed above. This is in striking contrast with the archaeological record which so far has only documented rock cairns. Obviously, preservation of dung, brush and earth cairns would be poor, yet we know of many jumps and pounds used into the historic period (Frison 1978), and one could reasonably expect these late sites to still exhibit perishable cairns.

Similarly, given the number of historic observations of pounds and jumps, one would expect at least a few cases of stone cairns being used. Clearly, a strong dichotomy exists between the materials used for cairn construction as observed in the archaeological record and as described in ethnohistoric literature.

We offer no resolution to this matter, but the HSI cairn study does permit a few observations. Prior to our excavations of the HSI drive lane cairns, it had been anticipated that a substantial pile of rock would be uncovered at each cairn location. We expected the visible cairn to be the remnant of a rock pile which once measured upwards of .5 m high and .75 m in diameter but which had been reduced to the present size through processes of sedimentation, natural slumping, topple, and pawing by bison and cattle. These anticipations were based on the descriptions of cairns in the ethnohistoric literature, which almost invariably describe cairns as being about this size. The explanation for the apparent regularity in cairn size, according to this literature, lies in the function of the cairns as locations where individual hunters could conceal themselves (see Verbicky-Todd 1984).

The results of the cairn excavations did not match our expectations (see Figures 124 and 125). Rocks did not appear slumped and kicked around. Great numbers of stones were not found under the surface. The present size and shape of the modern rock cairns is, in our opinion, similar to the size and shape of the cairns when they were used in prehistoric times. Clearly, no manipulation of these rocks would produce a stone pile of the size necessary to conceal a kneeling hunter. Likewise, it seems inconceivable that these small platforms of rock could, by themselves, have any power to move or steer bison. The rock piles currently form a platform of stone on the ground surface, and our data suggest that this is all they ever would have been. No piles of rocks sufficient in size to match the ethnohistoric cairn descriptions exist in our study area at HSI. The possibility should be considered, however, that the stone cairns served mainly as a base for the eventual construction of larger cairns using other materials.

Under this scenario, the rock component of the drive lanes would be augmented with piles of brush, dung or earth when the jump is to be used. Such perishable cairns would have to be upgraded frequently, perhaps every year or every few years. This system would seem labour intensive, as new cairn material would have to be collected on a regular basis. Rocks necessary to build a full sized cairn, on the other hand, would probably be hard to gather initially, but would only have to be collected once. The question should be asked that if perishable cairns were in fact being built, why bother constructing rock bases for these?

One possible answer rests with the frequency with which the jump was to be used. Data from HSI and most other communal kill sites in the plains are entirely unable to provide information on the periodicity of site use. HSI may have been used once a year for years on end; several times a year for many years and then abandoned for either short or long intervals; every ten or twenty years; and/or every other conceivable scenario. No scenarios can be judged more or less likely at this time. Given that it is entirely possible that the site would undergo extended periods of disuse (c. 25 years), and that the native hunters were fully aware that such periods would occur, the rock cairns may have served as permanent markers to record the locations of where drive lanes need to be constructed in order for the jump to work. That is, in light of the

Figure 124. Plan view of excavated cairn in drive lane 1.

Figure 125. Looking west along line of excavated cairns in drive lane 1.

complex understanding of topography and animal behaviour needed for a successful hunt and considering the importance of these communal hunting events and the amount of time and labour invested in them, one might expect some attention to be paid to ensuring that a method of driving bison which had proven successful be marked on the landscape in a durable fashion. Perishable cairns alone may entirely disappear in a ten to twenty year interval, and the mechanics of the driving operation would have to be remembered or rediscovered. A small clutter of rocks, insufficient as a full cairn but which adequately marks a potential cairn location, would serve as a permanent marker of a system which had proven effective.

Reher and Frison (1980) raise a variation on this issue when they discuss the remarkable stratigraphy of the Vore buffalo jump site in Wyoming. At this site, stratigraphic analysis was able to show that the site had been used on average every 25 years. What Reher and Frison found interesting about this was the implication that many members of society would therefore only participate in the operation of the jump once or twice in their lifetime. This raises the possibility that knowledge of how a particular site operates could be lost, a situation the authors say could be ameliorated by hunters using many other similar sites in the context of a regional exploitation of bison. At HSI, the possibility of abandonment of the site for 25 years could result in a serious loss of information pertaining to the operation of the jump. This may be especially true at HSI which, as mentioned, has the most complex and extensive drive lane system known anywhere in the plains. Stone piles marking the positions to build perishable cairns would be one way to help ensure continuity in knowledge of site operations over time.

The preceding speculations are an attempt to reconcile the differences between the cairns studied at HSI and those described in the ethnohistoric literature. A major flaw in the argument that small stone piles served as markers for perishable cairns lies in the spacing of the stone piles. As mentioned above, cairns in lane 1 and other lanes observed in the south pass are spaced only about 4 m apart. This is much closer than would be necessary to simply remind users of the site where the perishable drive lanes cairns should be placed. Rock piles spaced every 50 to 100 m would probably be sufficient to mark the boundaries of a drive route which has proven successful.

The amount of human effort expended to construct numerous lines of closely spaced rock cairns extending over many kilometres is such that it suggests the cairns themselves must have played a more direct role in the manipulation and driving of bison herds. Similarly, the overall regularity of the thousands of cairns - in terms of size, shape, rock content, etc. - argues for a direct and consistent function in the drive lane operation. If stone piles were made to permanently mark the locations where perishable cairns were to be built, there would be no need to have the stone cairns so consistently similar in size and shape.

We are left with the following: ethnohistoric literature makes record of cairns in pound and jump operations being made of perishable materials, never stone; archaeological sites exhibit stone cairns, not perishable ones; at HSI, cairns consist of small platforms of rock, not piles, and excavation has confirmed that these platforms were not likely any larger than as seen today; these rock platforms are clearly insufficient to either conceal waiting hunters or to act alone to steer bison; the size of the rock platforms may have been augmented by placing perishable materials on top, but this raises the question of why bother building the rock bases in the first place; one answer to this question is that the rocks served as a permanent marker of the lane system, but to achieve this, there is no need to have so many cairns so close together.

The whole subject of the structure and function of drive lane systems at communal bison kill sites is, in our opinion, one of the least studied and least understood aspects of this hunting strategy. What discussion there is on this subject has been provided mainly in the writings of George Frison. In several works, Frison (1974, 1978) has rendered his interpretations of the function of the drive lane cairns:

> Lines of stone piles leading to jump-offs may have had a variety of uses, both functional and otherwise, but the writer feels their placement was mainly to serve as an indicator of where the animals had to be contained in order to finally terminate the drive in a favourable location for a final stampede over the jump-off. They were, in a sense, simply traffic markers. The stone piles or drive lanes in many locations are placed in such a way that someone familiar with bison can interpret them as a device for orienting the driver's position in relation to the herd.... Stone piles probably

> served primarily to orient the drivers. This seems so since the line of stone piles often follows a rise or the edge of an escarpment in such a way that a man could quickly approach and observe the drive lane ahead without revealing himself to the animals.... The stone piles would have indicated very rapidly where to move in order to view the herd and establish a proper position in relation to it. If a driver's position was not exactly right, he could have ducked out of sight and moved either forward or back, whichever was necessary, and then oriented himself with another stone marker for proper position (Frison 1974:16).

We concur with Frison's first point, that drive lane cairns serve as an indicator of where the animals had to be contained. The placement of lanes at HSI consistently indicates an intentional exploitation of topographic features. As Frison notes, lanes tend to follow ridge crests or rises, although we also note placement of lanes downslope but parallel to ridge crests, such as lane 1 along the side wall of the south pass.

More problematic is Frison's idea that drive lane cairns are there to act as markers for the hunters - that they oriented the hunters with respect to the position of the herd. In light of Frison's scenario of hunters moving rapidly along a drive lane system using cairns as orientation points, we would again question the need for cairns to be spaced so closely together. Hundreds of cairns in a row with only 4 m between rock piles would seem far in excess of what would be required to achieve the goal of orienting the hunters' positions relative to the herd.

It would seem that a larger question must be addressed; that is, do people drive bison or do drive lanes drive bison? In other words, are cairns (whether made of rock, dung, brush, earth or combinations of these) built to hide hunters who, if necessary, will rise up and direct the herd, or are unmanned cairns in and of themselves capable of controlling herd movement? Again, the ethnohistoric literature indicates that people drive bison with the cairns serving as hiding places. But it should be noted that the eyewitness accounts of bison drives are largely based on observations of Europeans who were stationed at the ends of the drive operation, i.e., at the jump or the pound. Thus, they witnessed the behaviour of the hunters during the final stampede. Also, all accounts pertain to native groups in possession of horses. The implication is that the early stages of gathering and driving (as opposed to stampeding) bison were seldom, if ever, documented. Further, the presence of the horse may have influenced the early stages of driving bison more so than the later stages. The rationale is that horses would likely be more useful for transporting hunters throughout the collecting area and along the early stages of the drive system to help round up the bison and start them moving in the desired direction, but would not be useful in controlling the stampeding animals approaching the kill. At this point, a veritable "wall" of human hunters waving bison robes and shouting would likely be the most effective means (short of an actual structure, such as wooden walls) of ensuring that the bison terminate their journey at the appropriate spot.

Europeans seem to have recorded this phenomenon, but perhaps these observations only apply to the final states of the hunt. At HSI, the thousands of closely spaced cairns situated several kilometres from the kill argue against a method of operation as described in the ethnohistoric literature. No amount of amalgamation of various bands would provide enough hunters to effectively man the vast network of cairns at HSI. Given the great extent of the HSI drive lane system and the closeness of the individual cairns, it seems more likely that the cairns themselves were directly responsible for controlling the moving herds.

The question then becomes, how did these small platforms of rock function independently to direct the movements of bison herds. Clearly, in their present form they would be completely ineffective at this task. Thus, other materials must have been added on top of the rocks. Two of the ethnohistorically recorded materials, bison chips and sod, could have been used but there is no apparent reason to build the rock platforms as bases for these materials. That is not to say dung and sod were not used along the drive lanes, only that their use does not help explain the manufacture of thousands of small rock clusters. This brings us to what can be termed the oasis theory.

The bottom of a plant vase may often contain a gridded network of holes and spikes designed to trap and hold in place the stems of flowers being arranged in the vase. These arrangers are called an oasis. Examination of the rock cairns at HSI brings to mind the possibility of a similar function. These rock platforms, alone too small to hide hunters or steer bison, are generally single layers of rocks gathered together in a tight circular cluster. One possible function of these rocks would be to serve as a base for implanting the third material mentioned in the ethnohistoric literature - brush. Branches of small trees or shrubs could be wedged in between the rocks and thus held erect. If brush were to be used, rock cairns would likely be essential, as the hard packed soils across the region would make planting the ends of the brush into the soil nearly impossible. At the same time, only a small cluster of stones, not a large pile, would be required. Thus, the oasis theory posits that the primary function of the small rock cairns which make up the bulk of the HSI drive lane complex was to serve as a base for holding an arrangement (one or more branches) of brush.

The use of brush along a drive lane has one obvious advantage over dung, sod, etc. That is, it can move. The strong southwesterly winds which are ubiquitous to the region would cause the brush to move and flutter. This effect could even be enhanced by securing strips of material to the branches thereby augmenting the impression of substance and movement. This feature may have been an especially important factor in imitating the behaviour of the human hunters, and may have capitalized on the strong adverse reaction bison have to strange movement in their territory (see McHugh 1958). The net effect of such an arrangement might well be that unmanned cairns, especially closely spaced as are those under discussion here, were fully capable of controlling the movement of bison being driven or stampeded towards the jump-off. Such a system of controlling bison might well be applied particularly in the early stages of the drive far from the kill site. This would enable the hunters to concentrate the human component of the drive system near the terminus where, presumably, the greatest control is needed. This final scene may be what the European eyewitness accounts have recorded. The major flaw with the oasis theory is the intensive requirement of brush and the relative scarcity of this material over much of the collecting area. On the other hand, in the dry climate of the HSI region, brush placed erect in rock cairns could survive quite a few years, making it unnecessary to replenish the cairns every time the jump was to be used.

Given the data from our very preliminary study of drive lanes and cairns at HSI, it is suggested that drive lane cairns were in themselves an integral component of manipulating bison herds. When built in the manner described above, cairns would be impressive structures which conceivably could have successfully contained a moving herd with little or no assistance from the hunters. Rock piles served mainly as a support for brush, branches, or other materials. The archaeological visibility of such structures would be limited to the small piles of rocks. This system would be augmented by the addition of hunters behind the cairns during the final stampede when the drive lanes narrowed and when control was most crucial. The discrepancy between ethnohistoric accounts of drive lane use and the HSI cairn study may, in part, be due to the fact that early observers did not see (or at least did not record) the early stages of gathering and driving bison. Similarly, the persistent recording of cairns made of dung, brush and earth rather than rock could be due to the fact that early observers did not notice the small base of rocks which was used to support other materials in the cairn.

It is definitely not being suggested that all jumps or pounds employing drive lanes would have functioned in this manner. We are aware of other sites on the northern plains with rock piles markedly different (i.e., larger) than those at HSI. It is simply suggested that one way to make sense of the HSI cairns is to have them act as a support for brush, and to postulate that most of them could effectively manipulate bison without the presence of the hunters. These highly speculative interpretations need much more work. It would be interesting to know if, in fact, bison respond well to structures of the size, shape, spacing and composition described above. Experiments witn modern bison herds would be difficult to arrange but would be most informative. Also, we need more detailed studies of other bison kill sites, exploring the range of drive lane cairn systems represented at plains communal kills. If nothing else, it is clear that a critical component of communal kill operations - the drive lane system - has been overlooked by researchers who have apparently accepted these features as straightforward means of funnelling bison to a kill site. Closer inspection reveals that, in fact, we have almost no idea how these fascinating structures operated.

CHAPTER SEVEN

THE PETROGLYPH COMPLEX AT HEAD-SMASHED-IN BUFFALO JUMP SITE

INTRODUCTION

An important goal of the 1984 research objectives at HSI was the documentation of the lesser known aspects of the site complex to enhance the proposed interpretive programme for the display centre. We felt that the petroglyphs at HSI represented an element of considerable potential interest to future site visitors and, as these had never been studied, we proposed to include examination of the glyphs in our 1984 research design.

The existence of glyphs at HSI has been known for many years. When Junius Bird visited the site in 1938 he must have seen the main glyph concentration, for he identifies their location on a photograph of the site area. At present, glyphs are only known from the high ridge top above and to the south of the sandstone escarpment which forms the kill site (see Figure 2). Stories circulate that in the past some rock art was also visible along the vertical face of sandstone at the kill site, and on one or more of the quartzite glacial erratics which lie on the prairie a few kilometres east of the kill. We have been unable to locate any rock art in these two locations.

The known rock art at HSI occurs at two locations; the first is the main concentration of glyphs on the top of a high hill, the second is a small cluster of glyphs located on a ridge top some 900 m north of the first location (see Figures 2 and 126). Both glyph areas are to the southwest and west of the HSI kill site; the first (main) site is about 1.2 km from the kill, and the second site is about 0.7 km from the kill. The main glyph site covers an area of about 45,000 m^2 on top of a hill which forms the end of the ridge of the Porcupine Hills on which HSI is situated. The hilltop is predominantly exposed sandstone bedrock which in places forms a smooth, flat grooved surface, and in other places forms elevated hoodoo-like formations (Figures 127 and 128). Nearly all the exposed bedrock, except for the very freshly fractured surfaces, is rounded and smoothed by wind and water erosion. Some of the glyphs are

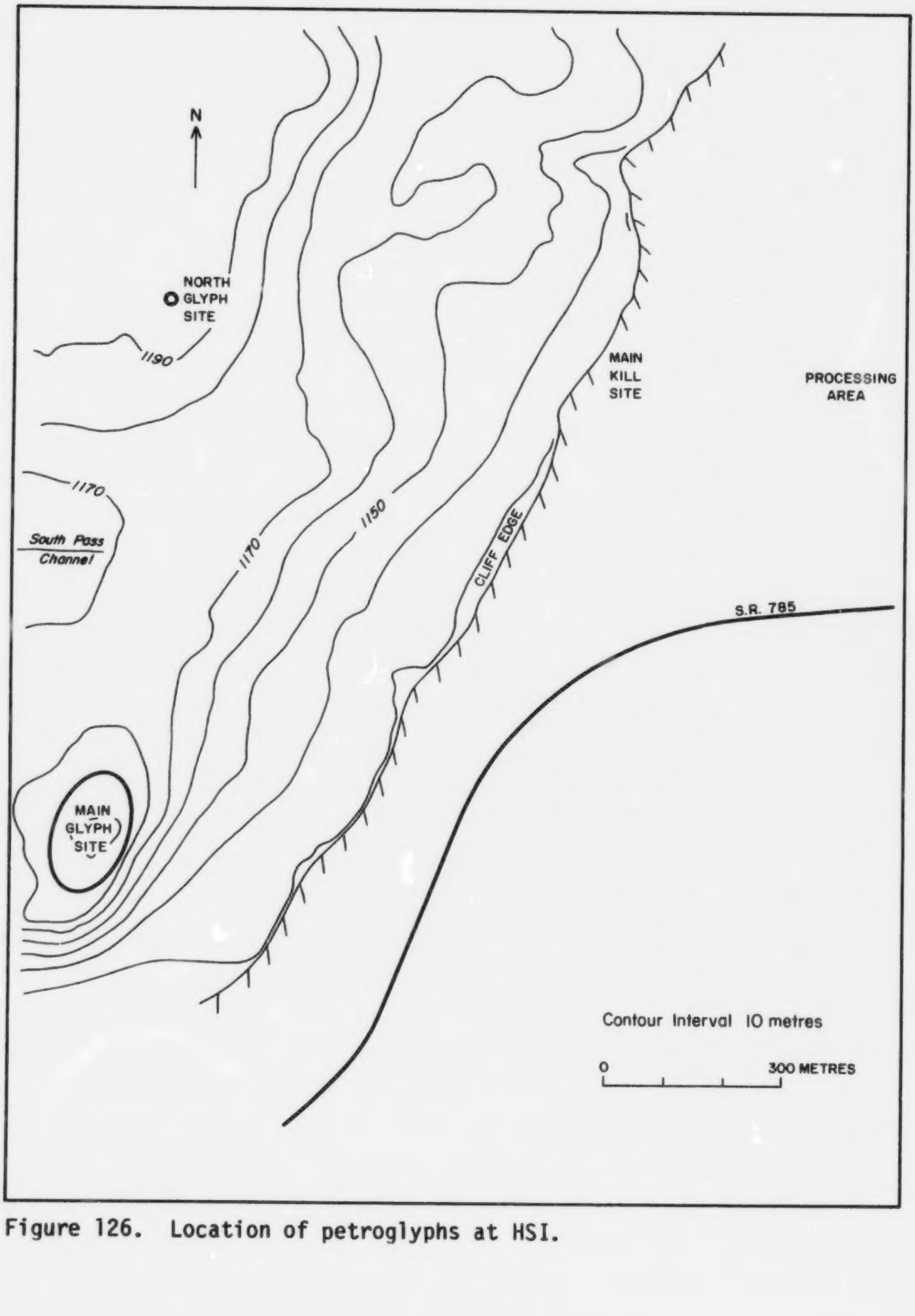

N
NORTH GLYPH SITE
1190
1170
South Pass Channel
1170
1150
CLIFF EDGE
MAIN KILL SITE
PROCESSING AREA
S.R. 785
MAIN GLYPH SITE
Contour Interval 10 metres
0
300 METRES

Figure 126. Location of petroglyphs at HSI.

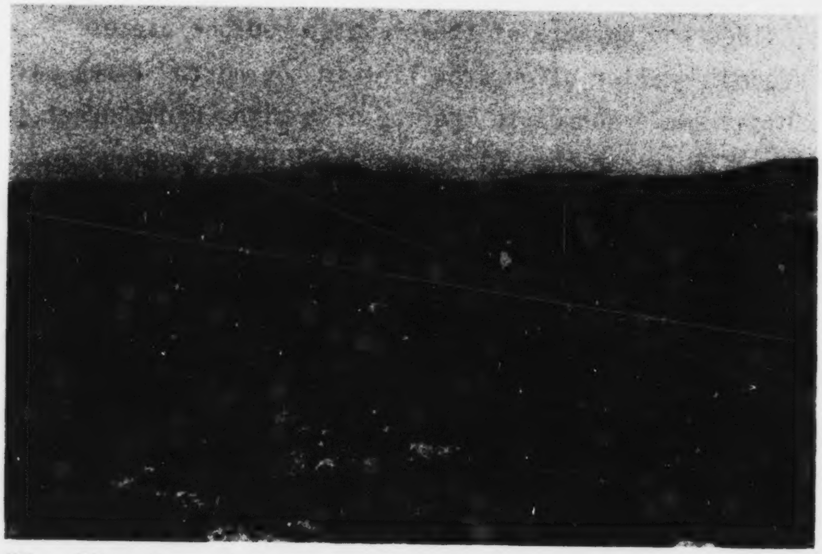


Figure 127. Flat-topped sandstone outcrops at the main glyph site.

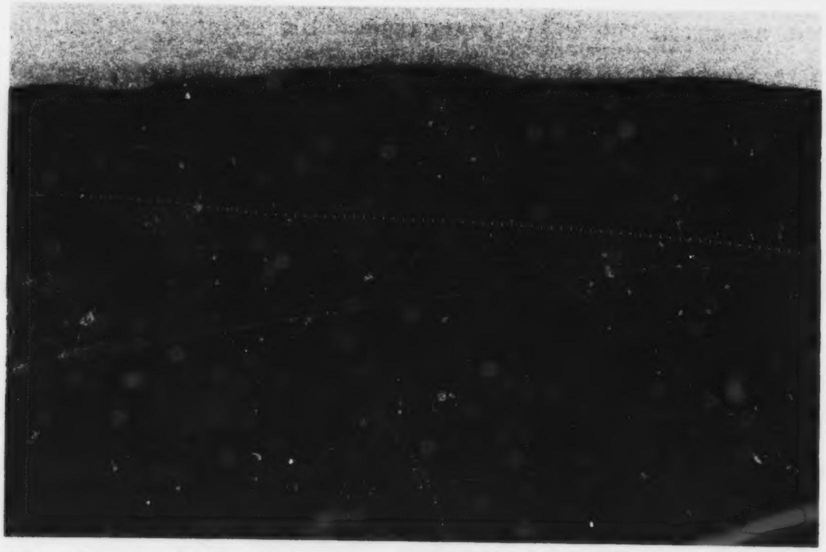


Figure 128. Hoodoo-like sandstone formations at the main glyph site.

situated on the flat surface bedrock slabs, while others are placed on the tops, sides and corners of the elevated bedrock pieces.

The second, smaller glyph area lies to the north of the main site, across a broad swale and up to the top of a minor ridge crest (see Figure 126). The swale is the channel of the south pass leading from the gathering basin to the kill site. A number of hoodoo-like sandstone bedrock formations are scattered along the crest of the ridge. The second glyph site is located atop a cluster of contiguous bedrock pieces (Figure 129).

METHODOLOGY

Our study of the HSI rock art included a foot survey to locate rock art occurrences, plotting the observed occurrences on low level aerial photographs and 1:10,000 topographic maps, and recording the glyphs by means of sketches, photography, written records and measurements.

The foot survey involved either one or two people and covered the area from the southernmost extent of the HSI escarpment, where the land drops off sharply to the level of SR 785 (basically the location of the main glyph site), to an area some 1.5 km north, where the south pass leads through the hills to the kill site. Throughout this rolling country are numerous occurrences of local sandstone outcrops and hoodoos, as well as the nearly continuous outcrop which forms the rim of the escarpment on which the kill is located. The country, measuring some 1.5 km north to south and 0.5 km east to west, was completely searched. All bedrock faces were examined for any signs of rock art. The main glyph site at the south end of the study zone and the smaller site 900 m to the north were the only two occurrences of rock art we were able to detect.

The small site was mapped by simply recording its location on aerial photographs and topographic maps. The large (main) site contains glyphs over a wide area. Here we decided to record glyph locations through the use of a grid system. Twenty metre squares were laid out with Brunton and chain along north-south and east-west axes. The grid squares were assigned alpha-numeric designations, and all rock art identified within each square was then numbered sequentially. Each individual glyph scene was examined and a written record was made of the etchings. This

Figure 129. Location of north glyph site.

description included the type and number of etchings, their measurements, the compass bearing of the linear elements, freehand sketches assisted with tape measures (not actual tracings), and black and white and colour photography. The nature of the glyphs was such that lighting was critical to both identifying and properly recording most of the images. Low angle light of early morning and evening was ideal, as the shadows produced by the glyphs made apparent what had been nearly invisible during mid-day. Repeated visits to the area under different light conditions resulted in continued identification of more scenes which had been passed over on previous visits. Because of unacceptable light conditions during much of our work and the repetitious nature of much of the rock art, only a few of the more distinct scenes were carefully photographed and sketched. It should also be noted that despite our intensive examination of this area, the possibility cannot be ruled out that a few very faint scenes were overlooked. Critical lighting and the faint nature of some scenes resulted in difficulty in identifying some images as definitely cultural in origin. Clearly, some scenes - both recognized by us and undetected - border on the verge of elimination through the processes of erosion.

DESCRIPTION OF THE PETROGLYPHS

Main Site

All but a few of the known glyphs at HSI are situated within what has been termed the main area on the hilltop to the southwest of the kill site. Within this area we defined twenty-nine occurrences of rock art. Separation of these occurrences was completely arbitrary; some glyphs are but a single groove located 50 m from the nearest glyph, while others occur in clusters where multiple images are found within a radius of a few metres. Our division of the glyphs into study units was done simply to facilitate recording. Designation of glyphs was done primarily on the basis of scenes found on a single rock face and should not be interpreted as an attempt on our part to infer any relationship between the various images.

The glyph designs at the main site exhibit a narrow range of variation. With one exception, the glyphs can all be classified as abstracts or geometrics. The exception is a possible zoomorph or anthropomorph. The great majority of the glyphs are simple grooved lines. Other designs include half circles, + marks, small crescents, possible V-shaped grooves, and one human or animal form. The V-shape motifs are questionable because they could be formed by the convergence of the common grooved lines and, thus, it is not known whether this was the original intent or whether it was simply fortuitous.

Grooved lines occur over the entire main site area (Figure 130). In total, there are approximately 185 individual grooves at the main site. The total is considered approximate because a few are so indistinct as to call into question their cultural origin. Grooves occur singly on a rock surface, but more commonly in groups of 2 to 23 (Table 31). The overall morphology of the grooves is decidedly similar: they range in length from 12 to 50 cm, in width from 2 to 16 cm, and in depth from .25 to 5 cm. Their mean length is 28 cm, the mean width is 6 cm, and the mean depth is 1 cm. Most grooves are V-shaped in cross-section. A few of the apparently more eroded grooves are now sub-rounded in cross-section, although some of these are so broad and rounded as to suggest they were originally etched out in a different fashion than the more common V-shaped grooves (see Figures 131 and 132). Whether or not the more

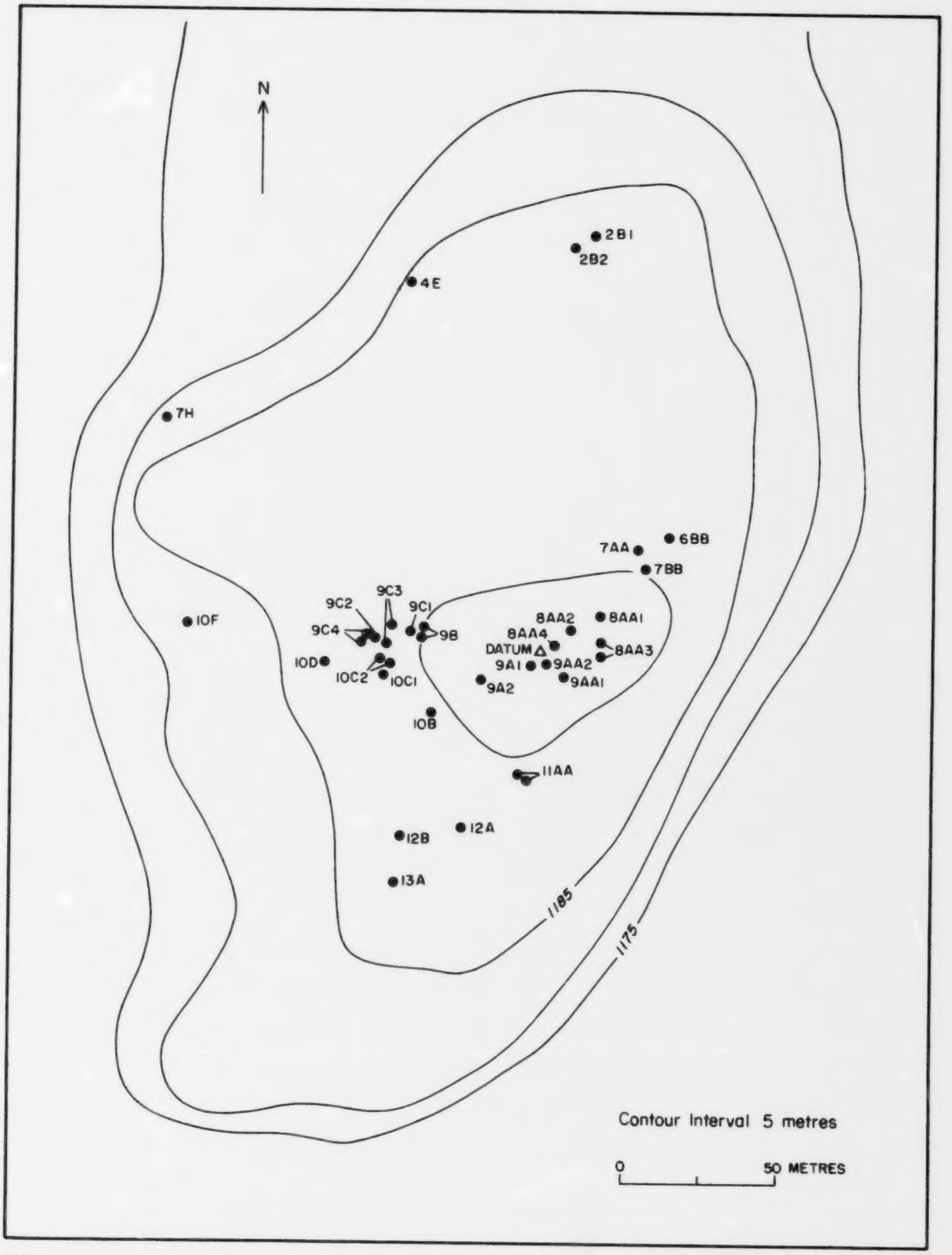

N
2B1
2B2
4E
7H
7AA
6BB
7BB
9C2
9C3
9C1
9C4
9B
10F
8AA2
8AA1
8AA4
DATUM
8AA3
10D
9A1
9AA2
10C2
10C1
9A2
9AA1
10B
11AA
12B
12A
13A
1185
1175
Contour Interval 5 metres
0
50 METRES

Figure 130. Location and reference codes for glyphs recorded at main site.

Table 31. Petroglyphs at Head-Smashed-In.

Glyph Ref. No.	Groove	+ Mark	Crescent/ 1/2 circle	Human/ Animal	Historic	V-Shape	Depression
MAIN SITE							
2B1	3						
2B2	1						
4E	4						1
6AA1	12					1	3
6BB	4						
7BB	23						1
7H	6						
8AA1	3						
8AA2	5						
8AA3	15						1
8AA4	5						
9AA1	4						
9A1	1						
9A2	1	3	4	1			
9AA2	2						
9B	6						
9C1	2						
9C2	5						
9C3	18					1	1
9C4	1	1	1				
10B	2						
10C1	1						
10C2	18						
10F					1		
11AA	7						
12A	6					1	
12B	15						6
13A	15						1
TOTAL	185	4	5	1	1	3	14
NORTH SITE							
1	1						
2	5					1	
3	17	1	1				
TOTAL	23	1	1			1	

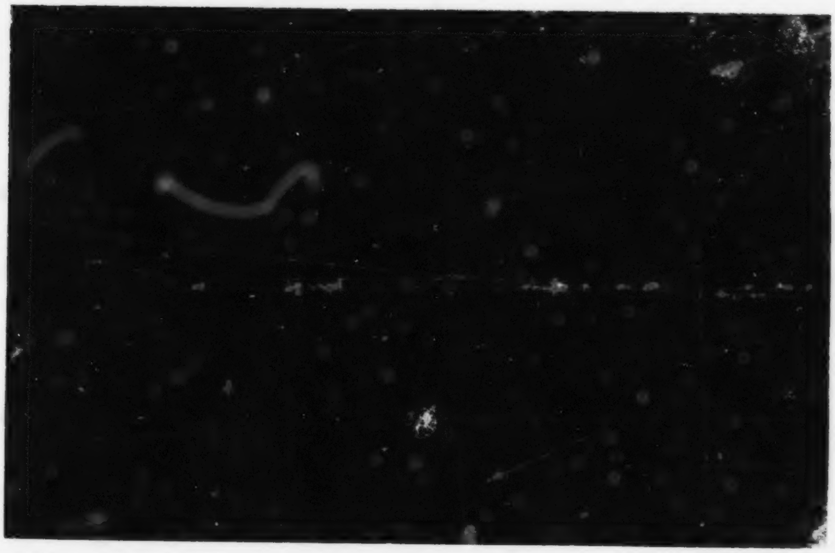


Figure 131. Linear groove with V-shaped profile.

Figure 132. Linear grooves with sub-rounded profile.

rounded grooves are simply eroded V-shaped grooves (and hence probably older glyphs) or whether they were actually executed in a different fashion cannot presently be determined. Noteworthy, however, is the fact that the more rounded grooves generally appear more weathered than the V-shaped grooves.

Although the grooves occur over a wide area, the great majority are contained in a restricted zone covering about 3500 m^2 (see Figure 130). The largest cluster of grooves on one rock face is 23; this number occurs twice. These clusters tend to occur on single contiguous slabs of bedrock in tight groups, which suggests that they were intentionally placed together and may have been executed at the same time (see Figures 132 and 133). Often many of the grooves within a cluster run parallel to each other (Figure 134), although it is also common to have grooves at right angles to adjacent grooves (Figure 134).

As mentioned, we measured the compass orientation of all grooves. While hoping an overall preferred orientation would emerge, this does not seem to be the case. Figure 135 displays a "rose diagram" of the groove orientations in 15^{0} increments. As can be seen, all directions are represented, although there is a slight bias towards grooves which align along an axis northwest to southeast (n=46; 25%), and along an east to west axis (n=38; 21%). These are calculated using magnetic north, uncorrected for local declination. In the Fort Macleod area, magnetic north is currently about 20^{0} east of true north. Compensating for this fact would make our measurements more relevant to the directions likely to have been recognized by the aboriginal artisans, but does not substantially alter our analysis. The slight trend towards northwest-southeast grooves would shift more towards true north-south, and the east-west trend would be strengthened slightly. Thus, we can say that there is some tendency for grooves to align north to south and east to west, but that variation from these trends is common.

What is more conspicuous is the obvious tendency for grooves occurring in a cluster to be parallel and, not uncommonly, to have two sets of parallel grooves with the sets at right angles to each other (see Figures 132, 134, 135 and 136). A good example of this is locality 7BB (see Figure 130), where 23 grooves occur in two distinct clusters; one group is aligned very close to east-west, the other very close to

Figure 133. Location of groove cluster 7BB (View is east toward Oldman River Valley).

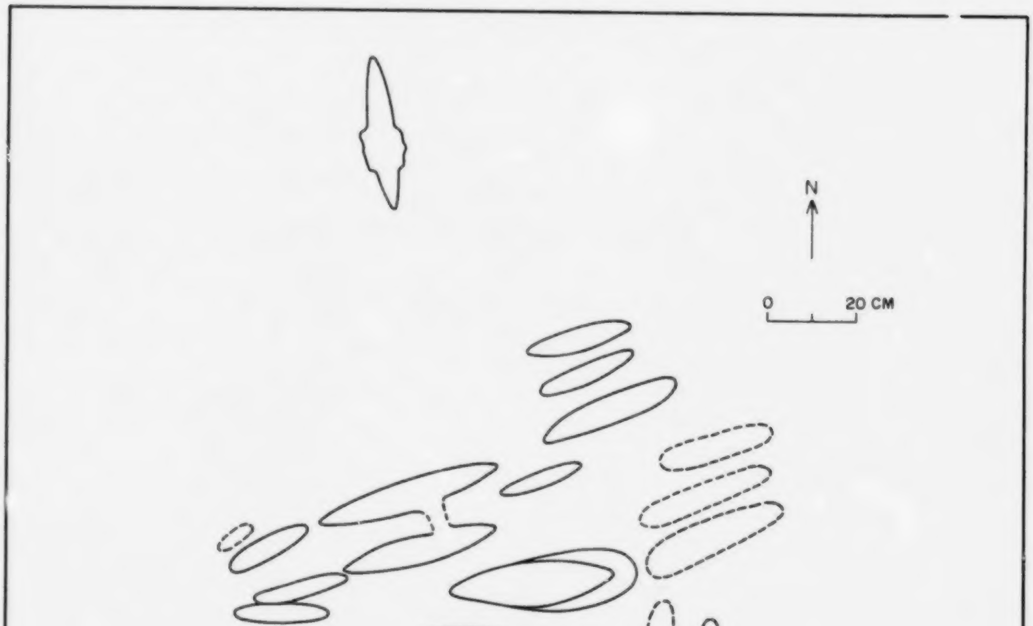


Figure 134. Detailed sketch of groove cluster 7BB.

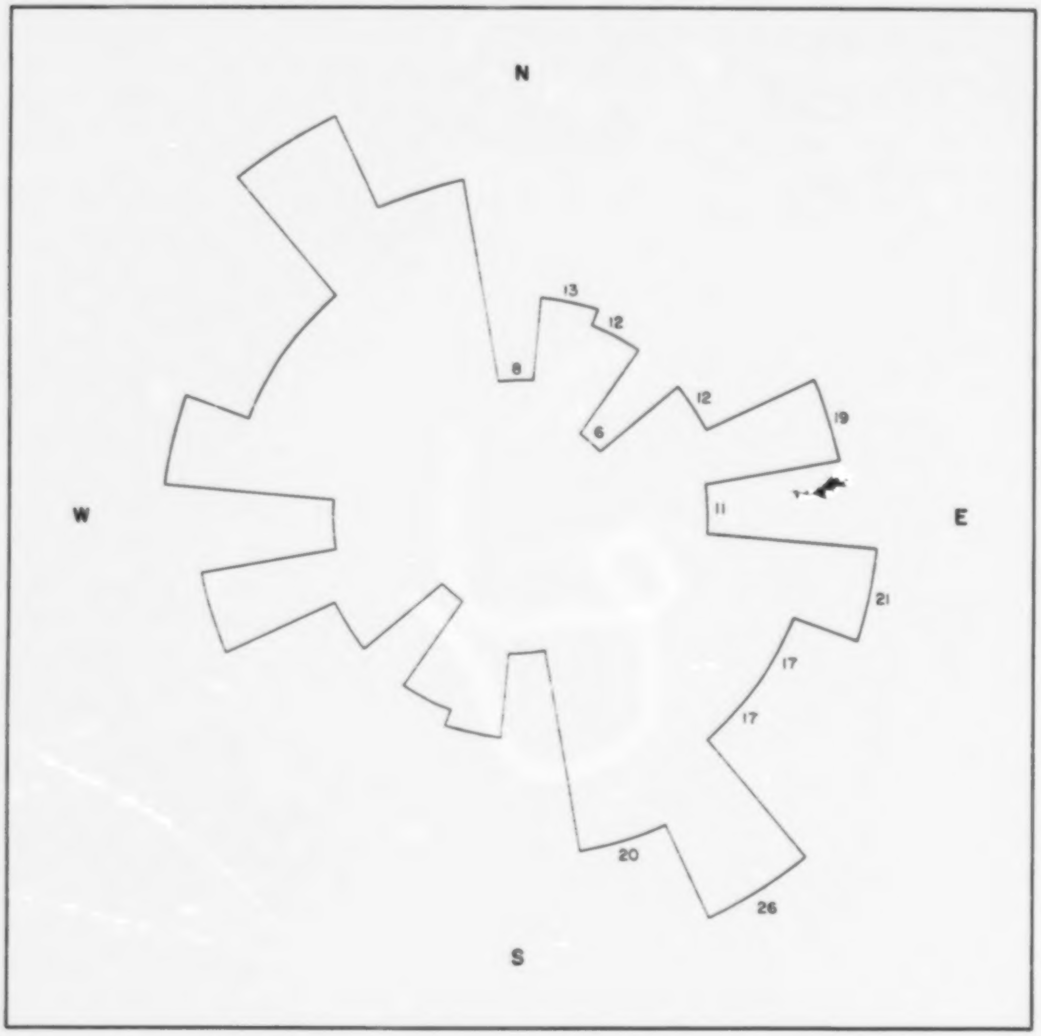


Figure 135. Rose diagram of grooves recorded in main glyph site.

north-south (true readings). A rose diagram of these grooves (Figure 137) displays the strong bimodal tendency of the orientations. In short, there is fairly clear patterning of groove orientation at most specific clusters at the main glyph site, but this patterning applies only to the grooves at each cluster and not to the site as a whole.

Other glyphs at the main site on the southern hilltop include what we will call depressions (Table 31). These are simply trough-like depressions, considerably broader than the grooves (see Figure 136). It seems quite likely that the manufacture of these glyphs is similar to that of the grooves, but, for whatever reason, a much wider channel is

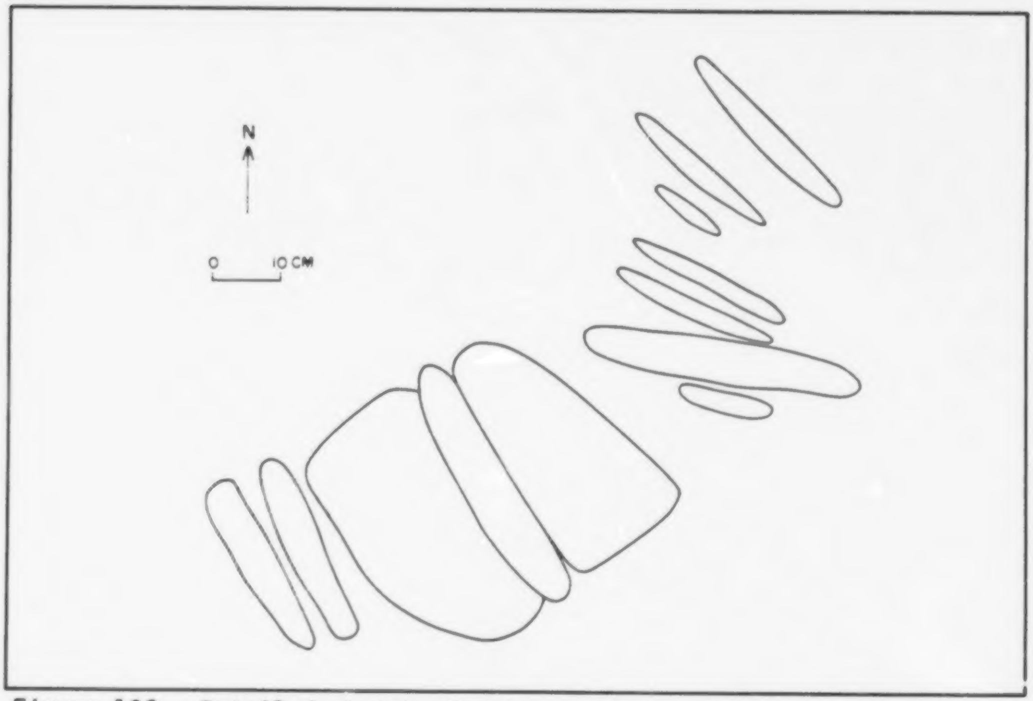


Figure 136. Detailed sketch of groove and trough cluster 12B.

gouged out of the sandstone bedrock. These depressions occur at a number of localities, but the majority (8 of a total of 14) occur at locality 12B (see Figure 130). This locality differs from the rest of the site in that here the glyphs occur on the vertical faces of a sandstone boulder rather than on flat lying bedrock (Figure 138). Grooves and depressions are etched on several faces of the boulder, creating an impression not unlike the "ribstones" known from other sites in Alberta (Wormington and Forbis 1965). The fact that grooves and the broader depressions occur together on the same rock faces (see Figure 136) strengthens the belief that these two motifs are closely related and simply represent a continuum of etching parallel lines.

One of the most interesting localities at the main site is 9A2 (see Figure 130) where a variety of rare glyphs are clustered. At this locality is the one glyph which may be a human or animal form. The design is oval in planform, measuring 40 cm on the long axis and 34 cm on the short axis. A natural raised ridge of sandstone bedrock has been modified into the oval form by pecking a curved line around to join the ends of the natural ridge. On the outside edges of the oval are pecked

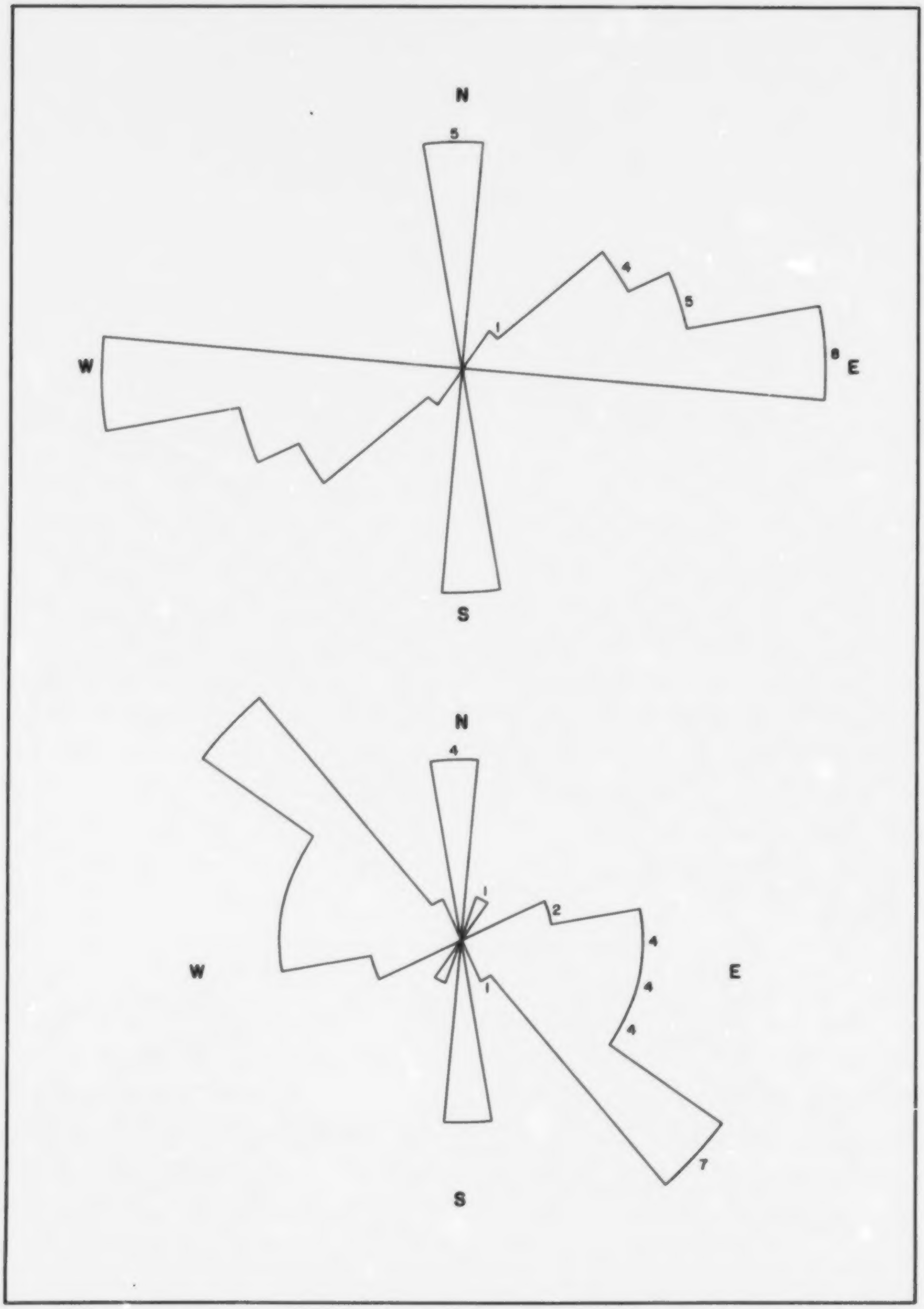


Figure 137. Rose diagram of groove cluster 7BB (upper) and groove clusters in north glyph site (lower).

Figure 138. Location of groove and trough cluster 12B in main glyph site.

out four "appendages" to the body. One is rounded and resembles a head; the other three are linear and resemble arms or legs (see Figures 139 and 140). Inside the oval body are additional peckings which are quite faint and difficult to record. One pecking resembles a zig-zag line; others are simply amorphous in their present condition. Overall, the image is of a round body form with attached appendages which we believe to be an animal or human form. If animal, the glyph is most similar to a turtle. If human, the form is suggestive of the so-called "shield bearing warrior", where the human body form is largely hidden by the shield with only the appendages protruding. We do not feel it is possible to make a definitive decision on this glyph, but we lean towards the interpretation that it is a turtle effigy. We do so because of the considerable difference between this glyph and the common shield bearing figure in northwestern plains rock art traditions (Keyser 1977).

At the same locality (9A2) are several more designs which are also rare at the site. These include crescents or half circles and + marks. Two short crescents are placed a few centimetres to the southeast of the turtle effigy in such a position that they may have played a role as an additional appendage of this figure (Figures 139 and 140). Between 50 and 130 cm south of the turtle effigy are 3 + marks and 2 crescents or half circles. Two of the + marks are deeply pecked into the rock

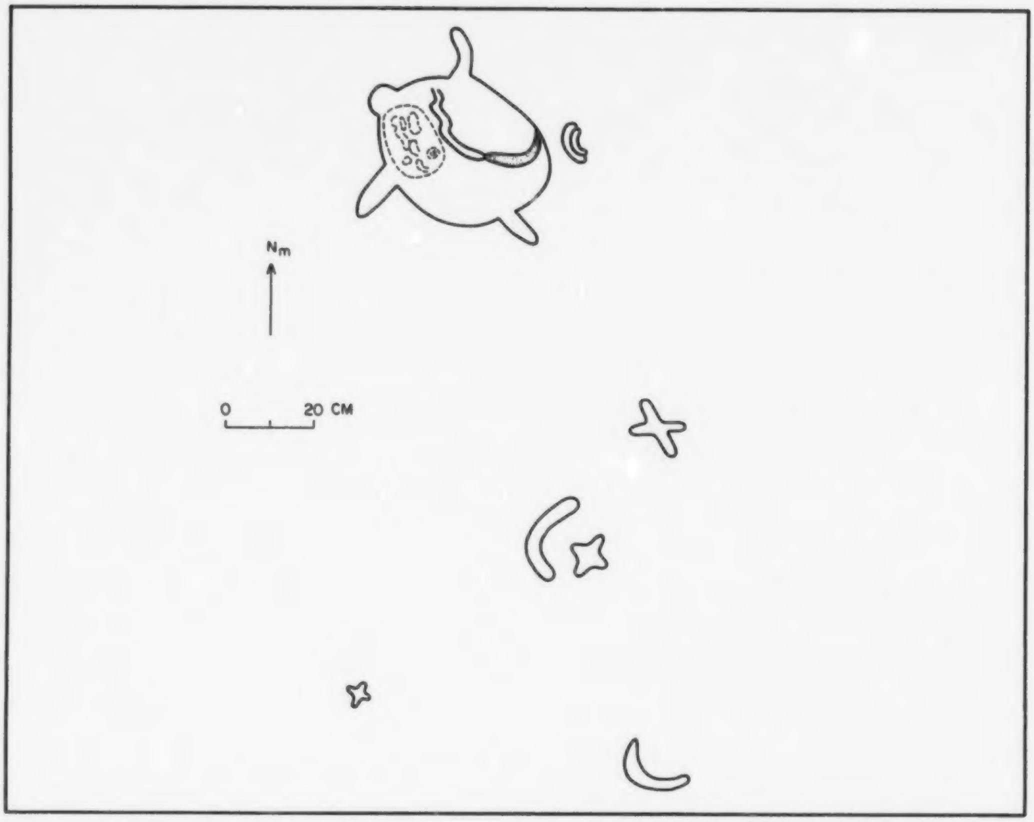


Figure 139. Detailed sketch of glyph cluster 9A2 in main glyph site.

(1-2.5 cm) such that their form and cultural origin are unmistakable. Similarly, the half circle which lies a few centimetres directly west of a deep + mark is also deeply pecked. The association of + marks and crescents or half circles is repeated several times at HSI, once at locality 9C4 of the main site (see Figure 130), and again at the north glyph site described below. Neither + marks nor crescent shapes ever occur by themselves.

The final main site glyph to be discussed is a historic period inscription which has been etched inside a round cavity in a large sandstone boulder (glyph 10F, Figure 130). The cavity faces south and is provided with an overhang, thus protecting the inside of the cavity (see Figures 128 and 141). Inside the cavity is inscribed a religious cross and the capital letters OMI (Figure 142). These would certainly stand for the Order of Mary Immaculate, or the Oblates, and the inscription is likely the work of one of the Oblate missionaries stationed in the

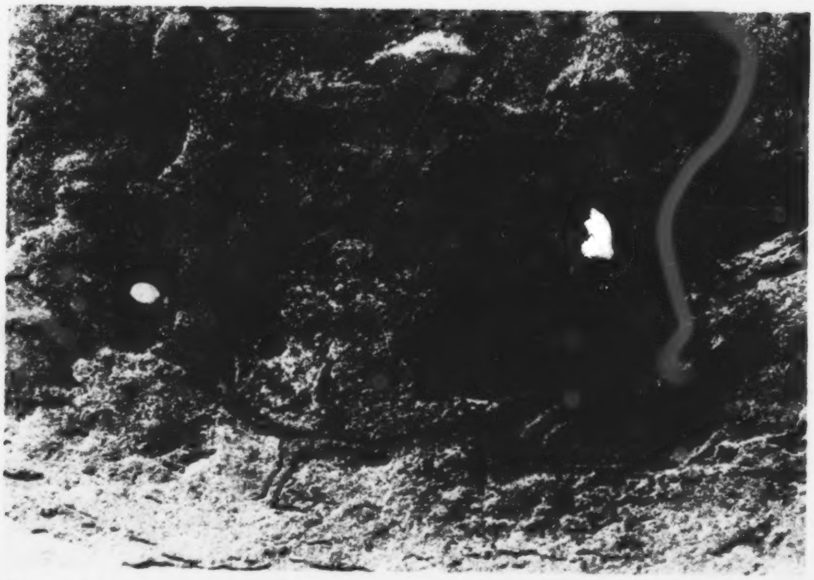


Figure 140. Detail of possible turtle effigy in glyph cluster 9A2.

Figure 141. Location of glyph 10F. Note overhang protecting glyph.

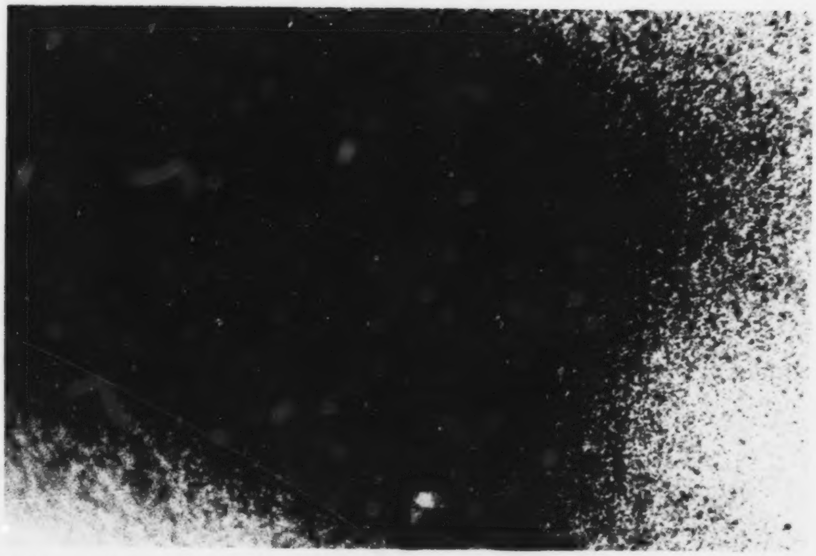


Figure 142. Close up of glyph 10F.

Pincher Creek-Fort Macleod area during the nineteenth century. While it cannot be ruled out that the work was done later by someone other than an Oblate, this strikes us as a less plausible explanation. The preservation and clarity of this glyph is excellent and is probably due to the protected nature of the setting. This is the only definite historic glyph located at HSI except for the occasional name or initial found on sandstone bedrock over the whole site area.

North Site

During our 1983 field season, a second series of glyphs was discovered which we believe had not previously been observed. This area has been labelled the "north" site, and it is situated about 900 m north of the main site (see Figure 126). The north site lies on the crest of a small local ridge which marks the highest point on the north side of the so-called "south pass" leading from the gathering basin to the kill. On this ridge crest are numerous outcrops of sandstone bedrock, some of them taking the form of flat ground cover, others as rounded bedrock boulders (see Figure 129). The glyphs here are placed on the tops and sloping sides of the bedrock.

Three separate glyph localities were identified. Two of these are on bedrock boulders immediately adjacent to each other; the other is a single groove on a flat bedrock slab located some 15 m south of the two boulders. In total, there are 25 grooves, one half circle, and one + mark at the north site. Two of the grooves converge to form a V-shape and are listed as such in Table 31. The grooves range in length from 16 to 50 cm, in width from 3 to 16 cm and in depth from .25 to 3.5 cm. The mean length is 30 cm, the mean width is 5.8 cm, and the mean depth is 1.2 cm. These figures are nearly identical with those given above for the grooves in the main site area.

Groove orientation is more uniform at the north site (Figure 143). This is probably due to the fact that all but one of the grooves are placed on two contiguous rock surfaces. As mentioned above, groove orientation at the main site was strongly patterned at specific localities but tended to diminish as more localities were considered. At the north site, the fact that all but one of the grooves are found within a few metres of each other results in the expected tendency towards lines being parallel. As seen in the rose diagram (see Figure 137), the majority of grooves are oriented northwest to southeast, again with a tendency for a few grooves to be placed nearby at a right angle to the primary orientations (Figure 144). With respect to size, orientation and style of excavation, the grooves are essentially identical to those

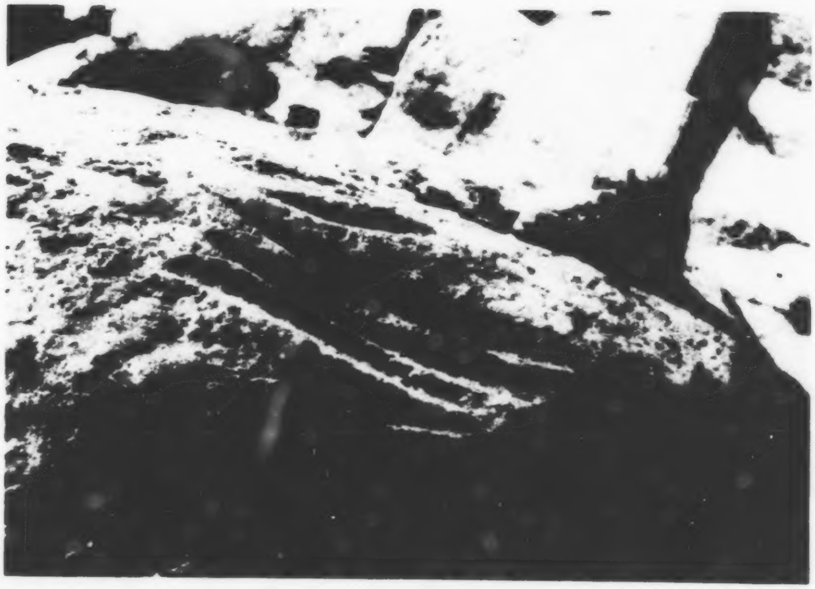


Figure 143. Groove cluster at north glyph site.

observed at the main site. The only potential difference was our subjective impression that the north grooves were more weathered and had more lichen cover over many of the etchings. All grooves, as well as the other glyphs at the north site, were quite distinct and generally deep, but they appeared more rounded and eroded than some of the deep and sharp-sided grooves at the main site.

Aside from the grooves, the only other glyph at the north site was a single + mark and half circle (see Figures 144 and 145). As at the main site, these were again directly associated on one rock face, with the half circle partially surrounding the + mark. The composition of this design is identical to the occurrences at the main site with the exception that the north design is substantially larger. The diameter of the half circle is 43 cm, and the lines of the + mark are 16 and 19 cm long. This is about twice as large as the equivalent images at the main site. In terms of size, clarity and geometric evenness of the lines, this glyph is perhaps the best executed of all those recorded at HSI.

DISCUSSION

Interpretation of the HSI glyphs is highly problematic. This is due in part to the subjective assessment of most rock art in general, but especially given the abstract nature of the HSI glyphs. Simple parallel grooves make up the vast majority of HSI glyphs. These do not immediately present enormous interpretive potential. Etched or incised parallel lines are a very common element at the Writing-On-Stone petroglyph site in southern Alberta, where they have been called "tally marks" (Habgood 1967; Keyser 1977). The implication is that they were used to keep count of some event. As these marks are usually found in association with other glyph scenes, it has also been suggested that they may represent sharpening grooves where implements used to make other glyphs are rejuvenated (Keyser 1977). Keyser (1977:47) notes, however, that these grooves occasionally occur by themselves where their function could not have been to touch up glyph engraving tools and that, in such cases, the grooves may have had some intrinsic importance to the artists. Aside from Writing-On-Stone, incised parallel grooves are rare in Alberta (Brink 1981) but are documented at other Plains rock art sites

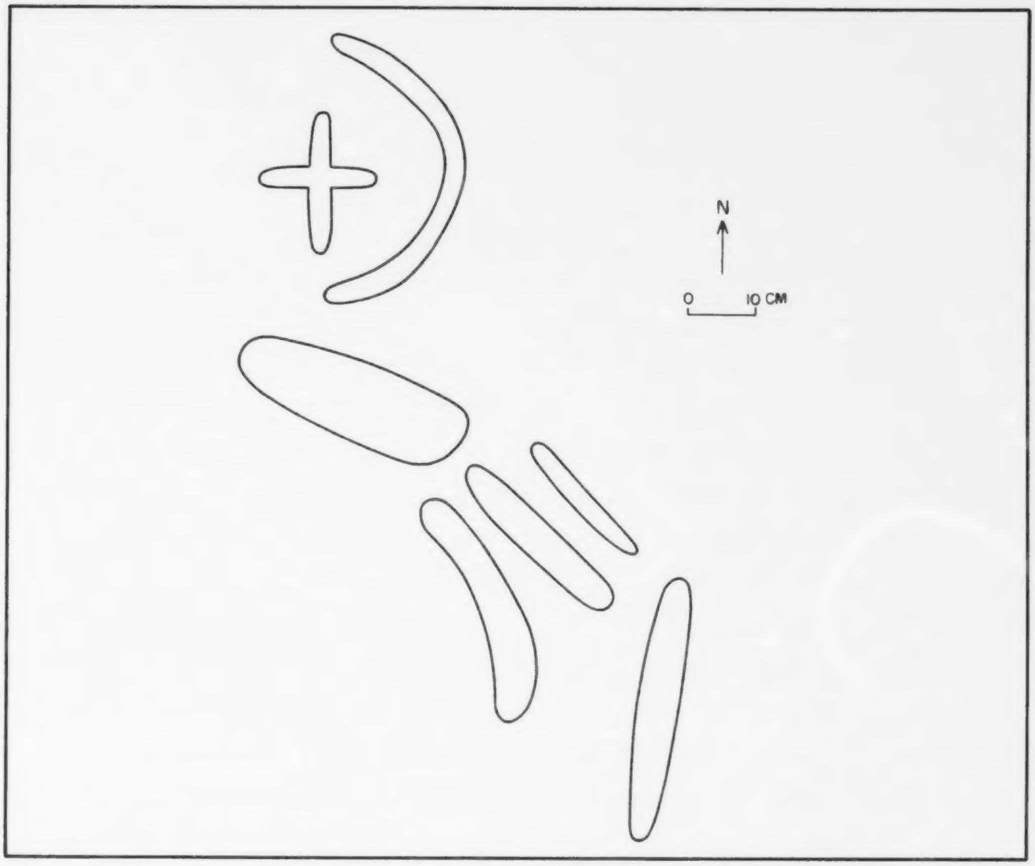


Figure 144. Detailed sketch of glyphs in north site.

Figure 145. Close up of half circle and + in north glyph site.

in Montana (Connor and Connor 1971). It should be kept in mind that glyph sites in Alberta are the exception; the glyphs at HSI represent the first known glyph site outside the Writing-On-Stone area; all other rock art sites in the province are pictographs (Brink 1981; Habgood 1967). This does not consider ribstones or other pecked boulders as rock art.

Parallel lines painted with red ochre do occur at a few Alberta pictograph sites. For example, at the Cline River site in the central Rocky Mountains west of Nordegg, a long row of over 50 short parallel lines are painted along a lip of rock which covers other pictograph scenes (Brink 1981). Again, whether these marks were for counting, were simply artistic, or functioned in some other practical or esthetic sense cannot be determined. Obviously, with grooves being the overwhelming glyph at HSI, they cannot have functioned as sharpening grooves used to rejuvenate the tools used to produce the few remaining glyphs. They may have functioned as sharpening grooves to sharpen some other class of tool, such as items made of bone, wood or antler.

The half circle with the + mark next to it occurs at both the main and north glyph sites. Since neither image appears alone, we must conclude that this association is intentional. The motif is one which, as far as we know, has not previously been documented in Alberta. Circles, sometimes with internal designs, are found at several sites (e.g., Zephyr Creek, Brink 1980). Cross-like or + marks are common at the Okotoks erratic pictograph site but circles or half circles are absent. At present, we have no explanation as to the possible meaning of the + mark and half circle.

The single possible effigy figure is equally problematic. Human and animal forms are known at nearly every rock art site in Alberta. In many cases, the forms can be identified as either human or animal, although often the specific animal depicted remains unknown. The effigy figure at HSI is ambiguous because it could be either a human (shield bearing warrior) or an animal (turtle). If, as we suspect, the figure is a turtle effigy, it becomes more difficult to interpret or compare because other ambiguous animal figures from other sites cannot confidently be identified as turtles. We know of no other definite turtle figures at rock art sites in Alberta, although there are reports of turtle effigies made of aligned rocks on the prairies (Quigg 1981).

In examining the meaning of these marks, it may be instructive to consider the location of the two glyph sites. Both the main and the north sites are on high, prominent spots which afford an excellent view, especially to the west, into the gathering basin (see Figure 127). It seems reasonable to posit that these are places where hunters would station themselves during the time that bison are being rounded up in the basin and moved towards the kill site. The main and north glyph sites flank the south and north sides (respectively) of the so-called south pass leading from the basin to the kill. The south pass is a valley or swale which would effectively serve to confine the herds as they leave the broad valley bottom of the basin area and begin to cross the ridge of the Porcupine Hills which has the jump-off on its eastern side. Both sides of the south pass are lined with rock cairns. Although Reeves (1978) has identified two main routes for moving bison over this ridge (the north and south passes), in our opinion, the south pass would have been the preferred route. This is because the western end of this swale tapers gently into the broad valley bottom of Olsen Creek and, thus, could potentially service herds brought in from nearly the entire basin, while the north pass would primarily service only herds in one small "finger" or tributary valley of the gathering basin. Thus, the main and north glyph sites are situated on each side of the main bison driving route. We would expect that during communal hunt operations, dozens or even hundreds of hunters were stationed in the south pass area to help man the drive lane cairns. The high vantage points at the glyph sites would offer excellent spots from which to view the progress of the drive as it proceeded from the basin into the south pass. Specific individuals may have been intentionally stationed at these spots, and it seems entirely plausible that the rock art at these sites was created at these times. This does not tell us whether the images found there are highly symbolic and fulfilled some important ceremonial function or whether the images are simply idle scratchings of people killing time while the bison were being gathered.

Unfortunately, there is little information from ethnohistoric or archaeological sources to help resolve the matter. Frison (1978, and references) has reported on several communal kills in the northwestern plains where some form of shamanistic/ceremonial activity is believed to have occurred. So far, these data consist of structural remains believed to represent lodges built for the shamans or medicine men/women who were critical in orchestrating the communal hunts. Stanford (1979) has reported on artifacts from a Colorado Paleo-Indian bison kill which he suggests were part of a ritualistic package carried by a shaman who directed the kill. To our knowledge, investigations at other communal kills have not yet revealed a clear association between rock art and bison kill sites. An exception to this may be Alberta, where site records indicate that as many as six known buffalo jumps have associated rock art (Brink 1981:71). Unfortunately, HSI is the only one of these which is now thoroughly recorded, and we can do no more at present but suggest that there may well be a tendency for rock art to co-occur with bison kills in Alberta. If such a pattern exists, it would tend to strengthen the interpretation that the rock art has been created at these sites for some magical or religious purpose rather than simply being the result of idle doodling.

In sum, the HSI glyphs are primarily simple incised lines which are difficult to interpret. We can find nothing in the etchings themselves which readily lends itself to interpretation or indicates whether the glyphs had any relationship with the communal buffalo hunts. We would argue, however, that the location of the glyphs on either side of what we believe to be the main route for driving bison to the HSI jump-off is in itself supportive of the argument that the glyphs did have some relevance to the kill site. The reported (but not well documented) co-occurrence of rock art and bison jumps in Alberta lends some weight to this position.

BIBLIOGRAPHY

Ahler, S.A., and R.C. Christensen
1983 *A Pilot Study of Knife River Flint Procurement and Reduction at Site 32DU508, a Quarry and Workshop Location in Dunn County, North Dakota*. Department of Anthropology and Archaeology, University of North Dakota. Submitted to the Dickinson District Office, Bureau of Land Management and to the State Historical Society of North Dakota, Bismarck.

Arthur, George W.
1975 *An Introduction to the Ecology of Early Historic Communal Bison Hunting Among the Northern Plains Indians.* National Museum of Man Mercury Series, Archaeological Survey of Canada Paper 37. Ottawa.

Bamforth, D.B.
1985 The Technological Organization of Paleo-Indian Small-Group Bison Hunting on the Llano Estacado. *Plains Anthropologist* 30:243-258.

Bedford, Jean N.
1978 Technique for Sex Determination of Mature Bison Metapodials. *Plains Anthropologist Memoir* 14:40-43.

Behrensmeyer, A.K.
1978 Taphonomic and Ecologic Information from Bone Weathering. *Paleobiology* 4:150-162.

1983 Patterns of Natural Bone Distribution on Recent Land Surfaces: Implications for Archaeological Site Formation. In *Animals and Archaeology: 1 Hunters and their Prey*, edited by J. Clutton-Brock and C. Grigson, pp. 93-106. British Archaeological Report International Series 163.

Behrensmeyer, A.K., D. Western, and D. Dechant Boaz
1979 New Perspectives in Vertebrate Paleoecology from a Recent Bone Assemblage. *Paleobiology* 5(1):12-21.

Behrensmeyer, A.K., and E. Dechant Boaz
1980 The Recent Bones of Amboseli National Park, Kenya, in Relation to East African Paleoecology. In *Fossils in the Making*, edited by A.K. Behrensmeyer and A.P. Hill, pp. 72-93. University of Chicago Press, Chicago.

Behrensmeyer, A., and A. Hill (editors)
1980 *Fossils in the Making: Vertebrate Taphonomy and Paleoecology*. University of Chicago Press, Chicago.

Binford, L.R.
1978 *Nunamiut Ethnoarchaeology*. Academic Press, New York.

Binford, L.R.

1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 3:255-273.

1980 Willow Smoke and Dogs' Tails: Hunter-gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45(1):4-20.

1981a *Bones: Ancient Men and Modern Myths*. Academic Press, New York.

1981b Behavioral Archaeology and the "Pompeii Premise". *Journal of Anthropological Research* 37:195-208.

1984 *Faunal Remains from the Klasies River Mouth*. Academic Press, New York.

Binford, L.R., and J.B. Bertram

1977 Bone Frequencies and Attritional Processes. In *For Theory Building in Archaeology*, edited by L.R. Binford, pp. 77-153. Academic Press, New York.

Brain, C.K.

1981 *The Hunters or the Hunted? An Introduction to African Cave Taphonomy*. University of Chicago Press, Chicago.

Brink, J.W.

1980 Archaeological Investigations in the Eastern Slopes Region, 1979 (Permit Numbers 79-25, 26, 27, 28, and 29). In *Archaeology in Alberta, 1979*, compiled by Paul F. Donahue, pp. 32-37. Archaeological Survey of Alberta Occasional Paper 15.

1981 Rock Art Sites in Alberta: Retrospect and Prospect. In *Alberta Archaeology: Prospect and Retrospect*, edited by T.A. Moore, pp. 69-82. The Archaeological Society of Alberta, Lethbridge.

Brink, J.W., and R.E. Morlan

1983 Archaeology and Taphonomy of the Spring Channel at Head-Smashed-In Buffalo Jump, Alberta. Paper presented to the 41st Plains Conference, Rapid City.

Brink, J.W., M. Wright, B. Dawe, and D. Glaum

1985 *Final Report on the 1983 Season at Head-Smashed-In Buffalo Jump, Alberta*. Archaeological Survey of Alberta Manuscript Series 1. Edmonton.

Brink, J.W., M. Wright, B. Dawe, and G. Trott
1984 Preliminary Report on the 1983 Field Season at the Head-Smashed-In Buffalo Jump, Alberta. In *Archaeology in Alberta, 1983*, compiled by D. Burley, pp.16-44. Archaeological Survey of Alberta, Occasional Paper 23. Edmonton.

Brown, G.M.
1980 A Hunter-Gatherer Base Camp in Upper Green River Basin. *Wyoming Archaeologist* 23(1):7-42.

Brumley, John H.
1976 *Ramillies: A Late Prehistoric Bison Kill and Campsite Located in Southeastern Alberta, Canada.* National Museum of Man Mercury Series, Archaeological Survey of Canada Paper 78. Ottawa.

1980 Manual for the Analysis of Butchered Ungulate Faunal Remains. Manuscript on file, Archaeological Survey of Alberta, Edmonton.

Campling, N.R.
1980 Identification of Swan River Chert. In *Directions in Manitoba Prehistory: Papers in Honour of Chris Vickers*, edited by Leo Pettipas, pp. 291-299. Association of Manitoba Archaeologists and Manitoba Archaeological Society, Winnipeg.

Carr, Christopher
1984 The Nature of Organization of Intrasite Archaeological Records and Spatial Analytic Approaches to Their Investigation. In *Advances in Archaeological Method and Theory Vol. 7*, edited by M.B. Schiffer, pp. 103-222. Academic Press, New York.

Collins, M.B.
1974 A Functional Analysis of Lithic Technology among Prehistoric Hunter-Gatherers of Southwestern France and Western Texas. Ph.D. dissertation, University of Arizona. University Microfilms, Ann Arbor.

Congram, Babs
1978 A Typological Analysis of Features from the Saamis Site (EaOp-6) and the Stampede Camp Site (EaOp-4). In *The Saamis Site: A Late Prehistoric - Protohistoric Campsite in Medicine Hat, Alberta*, by Laurie Milne-Brumley, pp. 199-248. National Museum of Man Mercury Series, Archaeological Survey of Canada Paper 79. Ottawa.

Connor, S.W. and B.L. Connor
1971 *Rock Art of the Montana High Plains.* The Art Galleries, University of California, Santa Barbara.

Cowie, Isaac
1913 The Company of Adventurers. William Briggs, Toronto.

Duffield, Lathel F.
1973 Aging and Sexing the Post-cranial Skeleton of Bison. Plains Anthropologist 18(60):132-139.

Dyck, Ian G.
1977 The Harder Site: A Middle Period Bison Hunters' Campsite in the Northern Great Plains. National Museum of Man Mercury Series, Archaeological Survey of Canada Paper 67. Ottawa.

Ebert, J.
1979 An Ethnoarchaeological Approach to Reassessing the Meaning of Variability in Stone Tool Assemblages. In Ethnoarchaeology: Implications of Ethnography for Archaeology, edited by C. Kramer, pp. 59-73. Columbia University Press, New York.

Ewers, J.C.
1958 The Blackfeet: Raiders of the Northwestern Plains. University of Oklahoma Press, Norman.

Fidler, P.
1792-93 Journal of a Journey Overland from Buckingham House to the Rocky Mountains in 1792 and 1793. Typescript of Unpublished Journal, J.G. MacGregor Collection, Provincial Archives of Alberta, Edmonton.

Finnigan, James T.
1982 Tipi Rings and Plains Prehistory: A Reassessment of Their Archaeological Potential. National Museum of Man Mercury Series, Archaeological Survey of Canada Paper 108. Ottawa.

Forbis, R.G.
1962 The Old Women's Buffalo Jump, Alberta. National Museum of Canada Bulletin 180, Part 1, pp. 56-123. Ottawa.

1977 Cluny, An Ancient Fortified Village in Alberta. The University of Calgary, Department of Archaeology Occasional Paper 4. Calgary.

Fredlund, Lynn B.
1981 Southeastern Montana in the Late Prehistoric Period: Human Adaptation and Projectile Point Chronology. Unpublished Ph.D. dissertation, Department of Archaeology, Simon Fraser University. Burnaby.

Fredlund, L.B., D. Herbort, and G. Munson
1985 Investigations at a Besant Stone Ring Site (32OL270) in Central North Dakota. In Contributions to Plains Prehistory, edited by D. Burley, pp. 116-154. Archaeological Survey of Alberta Occasional Paper 26. Edmonton.

Frison, G.C.
1967 The Piney Creek Sites, Wyoming (48JO311 and 312). *University of Wyoming Publications* 33(1):1-92.

1968a Daugherty Cave Wyoming. *Plains Anthropologist* 13(42):253-295.

1968b A Functional Analysis of Certain Chipped Stone Tools. *American Antiquity* 33:149-155.

1970 *The Glenrock Buffalo Jump, 48CO304: Late Prehistoric Period Buffalo Procurement and Butchering on the Northwestern Plains. Plains Anthropologist 15(50, Part 2).*

1971 The Buffalo Pound in North-Western Plains Prehistory: Site 48CA302, Wyoming. *American Antiquity* 36(1):77-91.

1973 *The Wardell Buffalo Trap 48SU301: Communal Procurement in the Upper Green River Basin, Wyoming. Anthropological Papers of the Musuem of Anthropology 48.* University of Michigan, Ann Arbor.

1978 *Prehistoric Hunters of the High Plains*. Academic Press, New York.

Frison, G.C. (editor)
1974 *The Casper Site: A Hell Gap Bison Kill on the High Plains. Academic Press, New York.*

Frison, G.C., M. Wilson, and D. Walker
1978 *The Big Goose Creek Site: Bison Procurement and Faunal Analysis. Occasional Papers on Wyoming Archaeology 1.*

Frison, G.C. and D. Walker (editors)
1984 The Dead Indian Creek Site: An Archaic Occupation of the Absaroka Mountains of Northeastern Wyoming. In *The Wyoming Archaeologist* 27(1-2):11-122.

Gould, R.A., D. Koster, and A. Sontz
1971 The Lithic Assemblage of the Western Desert Aborigines of Australia. *American Antiquity* 36:149-169.

Grayson, Donald K.
1984 *Quantitative Zooarchaeology*. Academic Press, New York.

Greiser, Sally T., T. Weber Greiser, S.M. Vetter, and A.L. Stanfill
1983 Sun River (24CA74): A Stratified Pelican Lake and Oxbow Occupation Site Near Great Falls, Montana. Report prepared for Department of the Army Omaha District, Corps of Engineers Omaha, Nebraska. On file, Archaeological Survey of Alberta, Edmonton.

Grinnell, G.B.
1893 *Blackfoot Lodge Tales*. David Nutt, London.

Grinnell, G.B.
1923 *The Cheyenne Indians: Their History and Ways of Life* (2 vols.). Yale University Press, New Haven.

Gruhn, Ruth
1969 *Preliminary Report on the Muhlbach Site: A Besant Bison Trap in Central Alberta*. National Museums of Canada, Bulletin 232. Contributions to Anthropology VII: Archaeology. Ottawa.

Gryba, E.M.
1983 *Sibbald Creek: A Record of 11,000 Years of Human Utilization of the Southern Alberta Foothills*. Archaeological Survey of Alberta Occasional Paper 22. Edmonton.

Guernsey, Karin M.
1984 A Brief Survey of Structure and Function of Firepits. In Final Report of Investigations along the Cities Service 12, 8, and 6 Inch Pipeline, Sweetwater County, Wyoming, edited by William Latody, pp. 296-307. On file at the Office of the Wyoming State Archaeologist, Laramie, Wyoming.

Habgood, T.
1967 *Petroglyphs and Pictographs in Alberta*. Archaeological *Society of Alberta Newsletter 13 and 14*.

Hanna, Margaret G.
1982 Pots and Populations: Alternate Analytical Techniques for Using Ceramics as Indicators of Social Units. Unpublished Ph.D. dissertation, Department of Archaeology, University of Calgary, Calgary.

Hare, P.E.
1980 Organic Geochemistry of Bone and Its Relation to the Survival of Bone in its Natural Environment. In *Fossils in the Making*, edited by A.K. Behrensmeyer and A.P. Hill, pp. 208-219. University of Chicago Press, Chicago.

Harvey, D.
1969 *Explanation in Geography*. Edward Arnold, London.

Haugen, A.O.
1974 Reproduction in the Plains Bison. *Iowa State Journal of Research* 49(1):1-8.

Haynes, G.
1982 Utilization and Skeletal Disturbances of North American Prey Carcasses. *Arctic* 35(2):266-281.

1983 Frequencies of Spiral and Green Bone Fractures on Ungulate Limb Bones in Modern Surface Assemblages. *American Antiquity* 48(1):102-114.

Heitzmann, R.J.

1983 A Comment on Bone Pegs and Stone Circles. In Archaeology in Alberta, 1982, compiled by D. Burley, pp. 104-110. Archaeological Survey of Alberta Occasional Paper 21. Edmonton.

Hill, A.

1979 Butchery and Natural Disarticulation: An Investigatory Technique. American Antiquity 44:739-744.

Holland, Thomas D.

1984 A Pilot Study in the Thermal Properties of Buffalo Chips. Plains Anthropologist 29(104):161-166.

House, John H., and James W. Smith

1975 Experiments in Replication of the Fire-Cracked Rock. In The Cache River Archaeological Project, assembled by M.B. Schiffer and J.H. House, pp. 75-80. Arkansas Archaeological Survey, Research Series 8.

Huckell, Bruce

1978 Hudson-Meng Chipped Stone. Appendix 1 in The Hudson-Meng Site: An Alberta Bison Kill in the Nebraska High Plains, by Larry D. Agenbroad. University Press of America, Washington, D.C.

James, Edwin

1905 Edwin James' Account of S.H. Long's Expedition 1819-1820. Vols. 14-16 of Early Western Travels: 1748-1846, edited by Reuben G. Thwaites. Arthur H. Clark, Cleveland.

Jermann, J.W., and R.C. Dunnell

1979 Some Limitations of Isopleth Mapping in Archaeology. In Computer Graphics in Archaeology, edited by S. Upham, pp. 31-60. Arizona State University Anthropological Research Papers 15.

Johnson, Ann M.

1977 The Dune Buggy Site, 24RV1, and Northwestern Plains Ceramics. Plains Anthropologist 22(75):37-49.

Katz, P.

1976 A Technological Analysis of the Kansas City Hopewell Chipped Stone Industry. Ph.D. dissertation, University of Kansas. University Microfilms, Ann Arbor.

Kehoe, Thomas F.

1966 The Small Side-notched Point System of the Northern Plains. American Antiquity 31(6):827-841.

1967 The Boarding School Bison Drive Site. Plains Anthropologist 12(35). Lawrence.

Kehoe, Thomas F.
1973 The Large Corner-notched Point System of the Northern Plains. In *Aspects of Upper Great Lakes Anthropology: Papers in Honor of Lloyd A. Wilford*, edited by E. Johnson, pp. 103-114. Minnesota Historical Society, St. Paul.

Keyser, James D.
1977 Writing-On-Stone: Rock Art on the Northwestern Plains. *Canadian Journal of Archaeology* 1:15-80.

1979 *Late Prehistoric Period Bison Procurement on the Milk River in North-central Montana*. Archaeology in Montana 20(1).

Knudson, Ruthann
1983 *Organizational Variability in Late Paleo-Indian Assemblages*. Reports of Investigations 60. Laboratory of Anthropology, Washington State University, Pullman.

Kroeber, A.L.
1902 *The Arapahoe*. Human Relations Area Files (NQ6; Card 38, OCM #252.

Leechman, Douglas
1951 Bone Grease. *American Antiquity* 16(4):355-356.

Little, Barbara
1985 A Comparative Analysis of Spatial Patterns. In *Pattern Recognition in Archaeology*, edited by Ezra Zubrow and Barbara Little, pp. 34-40. American Archaeology 5(1).

Lorrain, Paul H.
1973 Some Observations on Stone Boiling. *The Record* 29(3):2-3. Dallas Archaeological Society.

Losey, Timothy C.
1972 *Archaeology of the Cormie Ranch Site, An Interim Report*. Archaeological Society of Alberta Newsletter 28. Edmonton.

Lowie, R.H.
1909 The Assiniboine. *Anthropological Papers of the American Museum of Natural History* 4(1):1-270. New York.

1954 *Indians of the Plains*. American Museum of Natural History. New York.

Lyman, R. Lee
1982 Archaeofaunas and Subsistence Studies. In *Advances in Archaeological Method and Theory Vol. 5*, edited by M.B. Schiffer, pp. 332-394. Academic Press, New York.

1984 Bone Density and Differential Survivorship of Fossil Classes. *Journal of Anthropological Archaeology* 3:259-299.

Lyman, R. Lee

1985 Bone Frequencies: Differential Transport, In Situ Destruction and the MGUI. Journal of Archaeological Science 12:221-236.

Magne, M. and D.L. Pokotylo

1981 A Pilot Study in Bifacial Lithic Reduction Sequences. Lithic Technology X(2-3):34-47.

McDowell-Loudan, E.E.

1983 Fire-cracked Rock: Preliminary Experiments to Determine Its Nature and Significance in Archaeological Contexts. The Thesopiean, A Journal of North American Archaeology 21(1).

McHugh, Tom

1958 Social Behaviour of the American Buffalo (Bison bison bison). Zoologica: New York Zoological Society 43(T):1-40.

1972 The Time of the Buffalo. Alfred A. Knopf, New York.

Miller, George J.

1975 A Study of Cuts, Grooves and Other Marks on Recent and Fossil Bone: II Weathering Cracks, Fractures, Splinters and Other Similar Natural Phenomena. In Lithic Technology, Making and Using Stone Tools, edited by Earl Swanson, pp. 211-226. Morton Publishers, The Vogue.

Moe, Jeanne, John W. Fisher, Jr., Steve Bolton, and Dennis Schoepp

1978 Artifact Descriptions. Appendix 1 in The Bootlegger Trail Site, A Late Prehistoric Spring Bison Kill, by Tom E. Roll and Ken Deaver. Heritage Conservation and Recreations Services, Interagency Archaeological Services. U.S. Governemtn Printing Office, Washington, D.C.

Morice, Rev. A.G.

1895 Notes on the Western Denes. Transactions, Canadian Institute, Vol. 4, 1892-93. Toronto.

Morlan, R.E.

1980 Taphonomy and Archaeology in the Upper Pleistocene of the Northern Yukon Territory: A Glimpse of the Peopling of the New World. National Museum of Man Mercury Series, Archaeological Survey of Canada Paper 94. Ottawa.

Mulloy, William

1954 The McKean Site in Northeastern Wyoming. Southwestern Journal of Anthropology 10:432-460.

Munson, Gene

1984 Features. In The Mitigation of Archaeological Site 32OL270, Glenharold Mine, North Dakota, Vol. 1, Narrative Report by L.B. Fredlund, D.P. Herbort and G. Munson, pp. 29-102. On file, G.M.C. Services Inc., Butte, Montana.

Neuman, R.W.
1975 *The Sonota Complex and Associated Sites on the Northern Great Plains*. Nebraska State Historical Society, Publications in Anthropology 6. Lincoln.

Paget, Amelia M.
1909 *The People of the Plains*. The Ryerson Press, Toronto.

Quigg, J. Michael
1975 Preliminary Investigation in the St. Mary and Belly River Regions: 1973. In *Salvage Contributions: Prairie Provinces*, edited by Roscoe Wilmeth, pp. 44-74. National Museum of Man Mercury Series, Archaeological Survey of Canada Paper 33. Ottawa.

1981 Stone Alignments. In *Alberta Archaeology: Prospect and Retrospect*, edited by T.A. Moore, pp. 59-68. The Archaeological Society of Alberta, Lethbridge.

Reeves, B.O.K.
1978 Head-Smashed-In: 5500 Years of Bison Jumping in the Alberta Plains. *Plains Anthropologist* 14(2):151-174.

1983a *Culture Change in the Northern Plains: 1000 B.C. - A.D. 1000*. Archaeological Survey of Alberta Occasional Paper 20. Edmonton.

1983b Six Millenniums of Buffalo Kills. *Scientific American* 249(4):120-135.

Reher, Charles A. and George C. Frison
1980 *The Vore Site, 48CK302, a Stratified Buffalo Jump in the Wyoming Black Hills*. Plains Anthropologist Memoir 16. Lincoln, Nebraska.

Reynolds, H.W., R.D. Glaholt, and A.W.L. Hawley
1982 Bison. In *Wild Mammals of North America. Biology, Management Economics*, edited by J.A. Chapman and G.A. Feldhamer, pp. 972-1007. The John Hopkins University Press, Baltimore.

Roe, Frank G.
1972 *The North American Buffalo. A Critical Study of the Species in its Wild State*. University of Toronto Press, Toronto.

Sadek-Kooros, H.
1975 Intentional Fracturing of Bone: Description of Criteria. In *Archaeological Studies*, edited by A.T. Clason, pp. 139-150. Amsterdam, North Holland.

Sampson, R.J.
1978 *Surface II Graphics System (Revision One)*. Series on Spatial Analysis 1. Kansas Geological Survey. Lawrence, Kansas.

Saylor, Barbara

1979 McKean Complex Projectile Points. *Manitoba Archaeology Quarterly* 3(2):16-21.

Schiffer, M.B.

1972 Archaeological Context and Systemic Context. *American Antiquity* 37:156-164.

1983 Toward the Identification of Formation Processes. *American Antiquity* 48(4):675-706.

Semenov, S.A.

1976 *Prehistoric Technology*. Translated, with a preface by M.W. Thompson. Harper and Row, Great Britain.

Simek, J.

1984 Integrating Pattern and Context in Spatial Archaeology. *Journal of Archaeological Science* 11:405-420.

Skinner, A.

1914 Notes of the Plains Cree. *American Anthropologist* 16:68-87. Washington.

Smith, S. and R. Cole-Will

1984 A Compilation of Sources on Pit Features in Northern Plains Occupations. On File, Archaeological Survey of Alberta, Edmonton.

Speth, John D.

1983 *Bison Kills and Bone Counts: Decision Making by Ancient Hunters*. University of Chicago Press, Chicago.

Speth, J.D., and K.A. Spielmann

1983 Energy Source, Protein Metabolism, and Hunter-gatherer Subsistence Strategies. *Journal of Anthropological Archaeology* 2:1-31.

Stanford, D.

1979 Bison Kill By Ice Age Hunters. *National Geographic* 155(1):114-121.

Swanton, John R.

1911 *Indian Tribes of the Lower Mississippi Valley and Adjacent Coast of the Gulf of Mexico*. Bureau of American Ethnology Bulletin 137.

Syms, E. Leigh

1974 History of a Refuse Pit: Interpreting Plains Camp Activities at a Microcosmic Level. *Plains Anthropologist* 19(63):306-315.

Tappen, N.C. and G.R. Peske

1970 Weathering Cracks and Split-line Patterns in Archaeological Bone. *American Antiquity* 35:383-386.

Thomas, David H.
1971 On Distinguishing Natural from Cultural Bone in Archaeological Sites. American Antiquity 36(3):366-371.

Thomas, David H. (editor)
1983 The Archaeology of Monitor Valley 2. Gatecliff Shelter. Anthropological Papers of the American Museum of Natural History 59(1).

Thomas, David H., and Deborah Mayer
1983 Behavioral Faunal Analysis of Selected Horizons. In The Archaeology of Monitor Valley 2. Gatecliff Shelter, edited by D.H. Thomas, pp. 353-391. Anthropological Papers of the American Museum of Natural History 59(1).

Todd, Lawrence C., Jr.
1983 Taphonomy: Fleshing Out the Dry Bones of Plains Prehistory. The Wyoming Archaeologist 26(3-4):36-46.

Turney-High, H.H.
1933 Cooking Camas and Bitteroot. Scientific Monthly 36:262-263.

1937 The Flathead Indians of Montana. American Anthropological Association, Memoir 48.

1941 Ethnography of the Kutenai. American Anthropological Association, Memoir 56.

Vehik, S.
1977 Bone Fragments and Bone Grease Manufacturing: A Review of their Archaeological Use and Potential. Plains Anthropologist 22(77):169-182. Lincoln, Nebraska.

Verbicky-Todd, Eleanor
1984 Communal Buffalo Hunting Among the Plains Indians. Archaeological Survey of Alberta Occasional Paper 24. Edmonton.

Von Enot, D.W., and D.J. Ortner
1984 Experimental Effects of Bone Size and Temperature on Bone Diagenesis. In Journal of Archaeological Science 11:247-253.

Voorhies, Michael R.
1969 Taphonomy and Population Dynamics of an Early Pliocene Vertebrate Fauna Knox County, Nebraska. University of Wyoming Contributions to Geology Special Paper 10. University of Wyoming.

Walde, Dale A.
1985 On Assigning Gender to Post-cranial Bison Bones. Unpublished Master's thesis, Department of Anthropology, University of Victoria.

Will, Richard T.
1985 Nineteenth Century Copper Inuit Subsistence Practices on Banks Island, N.W.T. Unpublished Ph.D. dissertation, Department of Anthropology, University of Alberta.

Wilson, Gilbert L.
1924 The Horse and the Dog in the Hidatsa Culture. Anthropological Papers in American Museum of Natural History 15(2):125-311. New York.

Wilson, Michael
1977 Archaeological Studies in the Longview-Pekisko Area of Southern Alberta: Permit 75-16. Report on file Archaeological Survey of Alberta. Edmonton.

Wissler, C.
1910 Material Culture of the Blackfoot Indians. Anthropological Papers of the American Museum of Natural History 5(1).

Wood, W. Raymond, and Donald L. Johnson
1978 A Survey of Disturbance Processes in Archaeological Site Formation. In Advances in Archaeological Method and Theory, Vol. 1, edited by M.B. Schiffer, pp. 315-381. Academic Press, New York.

Wormington, H.M., and Richard G. Forbis
1965 An Introduction to the Archaeology of Alberta, Canada. Denver Museum of Natural History Proceedings 11. Denver.

Wright, M.J., and B. Ball
1983 First Results from Dry Island Buffalo Jump Provincial Park, 1982. In Archaeology in Alberta, 1982, compiled by D. Burley, pp. 161-170. Archaeological Survey of Alberta, Occasional Paper 21. Edmonton.

Wright, M., B. Dawe, D. Glaum, and J. Brink
1985 Preliminary Results from the 1984 Field Season at Head-Smashed-In Buffalo Jump. In Archaeology in Alberta, 1984, compiled by D. Burley, pp. 81-101. Archaeological Survey of Alberta Occasional Paper 25. Edmonton.

APPENDIX 1

DkPj-21: A Description and Discussion of a Vision Quest Site in the Porcupine Hills, Alberta

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INTRODUCTION

The vision, as exhibited by North American Natives, was very much a pan-continental phenomenon. The common formula of isolation and self-mortification to gain spiritual power exhibits an almost continuous distribution north of the Rio Grande. In its most basic sense, the vision obtained by an individual consisted of "a culturally prescribed dream, hallucination, or any unusual auditory or visual stimulus which is interpreted as a communciation from supernatural entities and results in the recipient's acquisition of power, advice or ritual privilege" (Albers and Parker 1971:203).

On the Great Plains, the normal means of obtaining a vision was through the vision quest. While there exist comprehensive works on the social/psychological aspects of the vision quest (Albers and Parker 1971; Benedict 1922, 1923; Lowie 1958), there are very few comprehensive examinations of the archaeological manifestations of a vision quest event.

This paper will attempt to review some of the relevant ethnographic literature from Northern Plains with regard to the possible archaeological manifestations of the vision quest phenonmenon. This will be combined with a look at the archaeological literature for correlation with, and additions to, the ethnographic evidence with the hope of clarifying and exemplifying objective criteria for identifying a vision quest site. These criteria will then be applied to the description of a particular site, DkPj-21, with the ultimate aim of refuting or affirming its tentative vision quest status.

The "footprints" of spiritual beings and Native supplicants are not preserved in the archaeological record, nor are the processes of vision quest events spelled out by discrete clusters of time-sensitive artifacts. In fact, what most often characterizes a vision quest site is a small stone structure situated on a high, remote spot.

Archaeologists find rock features problematic because of the paucity of formal attributes. It should therefore be of considerable interest when one can attribute a functional significance to a rock structure (Chartkoff 1983). An increased understanding of vision quest sites and their inherent structures will ultimately improve our understanding of the vision quest's function for both individuals and social groups on the Northern Plains.

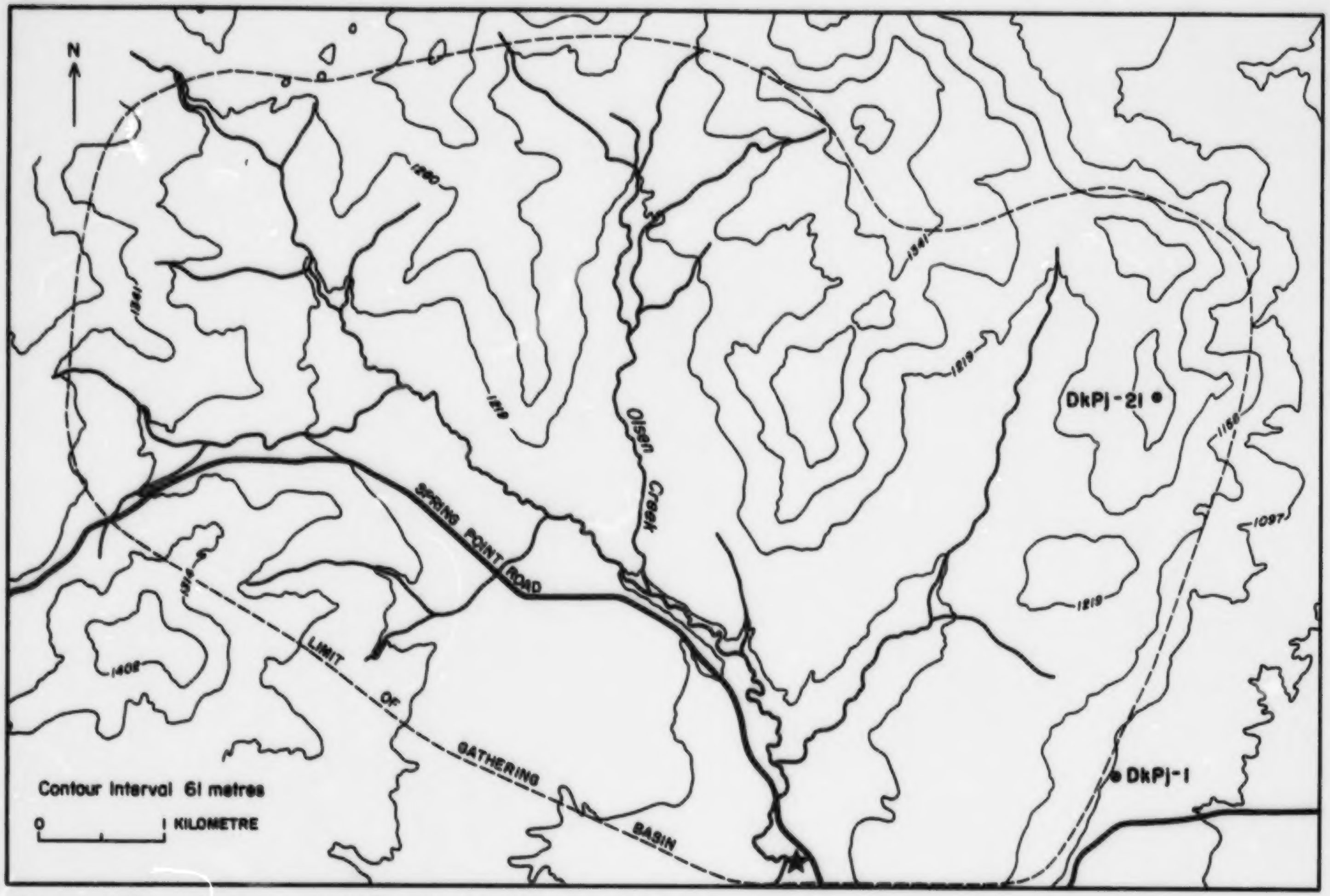
In the summer of 1984, DkPj-21, a site containing, among other things, a few such structures, was surveyed and tested. Located about 2 km north of Head-Smashed-In Buffalo Jump in southern Alberta (Figure 146), DkPj-21 has been tentatively called a vision quest site.

Since the interpretation of this archaeological site forms the bulk of this paper, the scope must necessarily be narrowed. DkPj-21 is on the Northern Plains. The groups that may have figured in the southern Alberta portion of the Northern Plains include the Blackfoot (Blood and Peigan), Gros Ventre, Plains Cree, Mandan, Hidatsa, Crow, Assiniboine, Sarsi, Shoshoni, Flathead, Pend d'Oreilles, and the Kutenai (Brink 1985). Of these groups, the important ones in terms of Head-Smashed-In include the Kutenai, Blackfoot, Gros Ventre, and Plains Cree. As a result, this paper will concentrate on the Northern Plains, drawing examples from the above groups.

ETHNOGRAPHIC AND ARCHAEOLOGICAL EVIDENCE FOR VISION QUEST SITES

The Ethnographic Data

Ethnographic data describe a vision quest site on the Northern Plains as typically occurring on an elevated piece of ground and consisting of an elongated circle or semi-circle, oriented on an east-west axis. Offerings were often brought and left by the supplicant, and there is



N
DkPj-21
DkPj-1
Olsen Creek
SPRING POINT ROAD
LIMIT OF GATHERING BASIN
1280
1219
1341
1158
1097
1408
Contour interval 61 metres
0
1 KILOMETRE

Figure 146. Location of DkPj-21 relative to HSI site complex.

some evidence that sites were repeatedly used and that they must be located, out of necessity, fairly near some sort of residential encampment.

More specifically, vision quest sites were often located on elevated ground for the Assiniboine (Lowie 1909:48), Blackfoot (Wissler 1912:105), Crow (Wildschut 1960:7), Gros Ventres (Cooper 1957:275), and Plains Cree (Mandelbaum 1979:159). For example, Wissler (1912) photographed what he called a Blackfoot structure on the summit of a hill near the Two Medicine River (Figure 147). It was oriented with its opening facing east and was built out of what appear to be sandstone slabs (Wissler 1912:105).

For the Gros Ventres, one of Cooper's informants gave this account of a vision quest of his father, Little Man:

> Little Man had [during a vision quest event] a little oblong nest with rocks piled up about two to three feet high, and open towards his feet. This is called his "call-for-power lodge" (Cooper 1957:286).

Similarly, Turney-High (1937:27) described a "low wall of stone" for a Flathead vision quest, and both Lowie (1956:240) and Wildschut (1960:7)

Figure 147. A "Fasting structure" near Two Medicine River (three feet in height [from Wissler 1912:105]).

describe a "resting place framed by rocks" and "a small rocky elevation about two to three feet high oriented to the east."

Offerings of "material goods" (Cooper 1957:281) among the Gros Ventre of old clothes and eagle feathers tied to a fan shaped bunch of twigs (Wissler 1912:106) for the Blackfoot, and of cloths (Mandelbaum 1979:159) for the Plains Cree, were brought to the vision quest site. As well, the repeated use of such sites is hinted at by Wissler (1912:106), Turney-High (1937:27), and Cooper (1957:286), for the Blackfoot, Flathead, and Gros Ventres, respectively. One informant for Cooper suggested some proximity of a residential encampment to a vision quest site because "they [the vision questors] get pretty weak from fasting and somebody has to come with a horse" (Cooper 1957:286).

Given such statements, can these physical characteristics be considered predictable attributes to be confirmed and augmented by archaeological research?

The Archaeological Data

Although not ubiquitous on the Northern Plains, vision quest structures have been reported by a number of individuals. A search through the site forms at the Archaeological Survey of Alberta produced some possible vision quest sites (in addition to DkPj-21), which are listed in Table 32. The incomplete nature of these site forms precludes anything but brief mention here.

The following individuals (Beckes and Keyser, Brink, Dormaar, Kehoe, Quigg, Reeves, and Wedel) seem to base their designation of sites as vision quests on two basic criteria from the ethnographic literature: small stone structures on high topographical eminences.

Quigg (1981:66) noted that less than 30 vision quest structures and effigies have been reported in Alberta but gives only one example. Brink (pers. comm. 1984) has heard of about a dozen vision quest structures in the Sweetgrass Hills in southern Alberta from John Dormaar, an amateur archaeologist, who noted that pieces of meat and cloth were left around these structures. Brink (pers. comm. 1984) has reported a vision quest structure on the top of Limestone Mountain, overlooking the Clearwater River valley in southern Alberta (Figure 148). Reeves (1971) mentioned an "overlook/ceremonial" structure near the Waterton townsite area in

Table 32. Possible vision quest sites in Alberta.

Borden No.	Description
DgOq-19:	a cairn and rocks forming a half circle on a hill on the south side of Milk River and the north side of Kennedy Creek. The structure has dimensions of 3 m north-south, and 2.5 m east-west. Some flakes were noticed in and around the hill.
DgPl-35:	an "overlook/ceremonial" site (discussed in text) in Waterton Lakes National Park.
DkPj-21:	the Porcupine Vision Quest site (discussed in text).
EdOq-62:	a semi-circular rock formation situated on the top of a hill on the Canadian Forces Base Suffield Military Reserve. Structure has an internal radius of 4 feet and its walls are 2.5 feet at the highest.
EeOq-25:	a collapsed stone shelter at one end of a large glacial erratic on the Canadian Forces Base Suffield Military Reserve. Structure is 3 m long by 1 m wide. Interpreted by the recorder as a vision quest structure.
EeOu-1:	an oval shaped stone ring located on a high, isolated hill with a panoramic view in Dinosaur Provincial Park. Dimensions are 4.5 feet by 3 feet with the long axis oriented north-south. Constructed of locally available sandstone slabs piled up 15-20 cm high. Interpreted by the recorder as a dream bed.
ElPu-13:	a circular stone structure located on the top of Limestone Mountain overlooking the Clearwater River valley in southwestern Alberta. Discussed in text (see Figure 148).

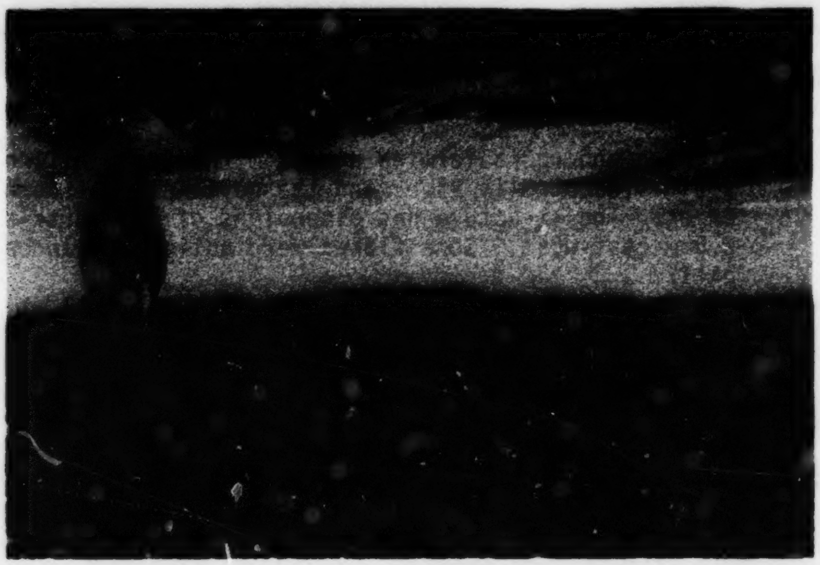


Figure 148. The Milt McGhee Vision Quest structure on Limestone Mountain in the Clearwater River valley of southwestern Alberta.

Waterton Lakes National Park. Kehoe (1960:459) described and photographed a vision quest structure on the Blackfoot Reserve (Figure 149).

In Montana and Wyoming, Beckes and Keyser (1983:339-40) reported on five structures in the Pryor Mountains. Keyser (1979) mentioned three "U-shaped rock walls" near the Fresno Reservoir just south of the Canadian border, and Wedel (1961:265-66) described a structure on the Dry Head Overlook in the Pryor Mountains.

None of the above references attempt to be anything but particularistic. Recorded instances of vision quest structures tend to be short, somewhat superficial, and sometimes hidden in lengthy, rather obscure reports (e.g., Beckes and Keyser 1983; Reeves 1971). Despite this unfortunate fact, the above isolated cases indicate a number of commonalities.

Sites that have been interpreted by archaeologists to include vision quest structures are located on topographical eminences (Beckes and Keyser 1983; Brink pers. comm. 1984; Kehoe 1960; Reeves 1971). In addition, some authors have noted that most structures are in locations with grand views across plains, valleys, and/or mountain ranges (Beckes

Figure 149. Fasting shelter of Ear Rings, Earrings Hill (southeast of Starr School on the Blackfeet Indian Reservation [from Kehoe 1960:Plate 53]).

and Keyser 1983; Dormaar pers. comm. 1984; Keyser 1979). While at the Dry Head Overlook in the Pryor Mountains of Montana, where at least five possible vision quest structures occur, Wedel described the location as:

> ... a lofty, wind swept plateau affording a magnificent panorama across Montana and Wyoming. Eastward, across the great canyon of the Bighorn River were the Bighorn mountains; northward, the broken plains rolled away to the haze of the Yellowstone valley; and seventy miles to the west, the snow banks of the Bear Tooth range shimmered in the June sun (Wedel 1961:265).

Stone structures that have been interpreted as those produced by a vision quest are also usually oriented on an east-west axis, made of dry-laid stone, and basically ovoid or U-shaped (Beckes and Keyser 1983; Kehoe 1960:459; Keyser 1979).

A site essentially lacking such stone structures but still interpreted as a vision quest is Old Man Mountain, a conical granite hill in northern Colorado. Because of the thorough nature of James Benedict's (1985) report on this site, it is worthy of mention here despite being located south of what is considered the Northern Plains and, therefore, somewhat outside the scope of this paper.

The Old Man Mountain vision quest site consists of five locations on the slopes to the summit containing burned bone, implements for preparing points, sharp edged obsidian flakes, flaked stone tools, projectile points, a steatite bowl fragment, numerous pottery fragments, and river cobbles from the valley below. The locations are interpreted as way-stations used for various preparatory purposes en route to the summit (Benedict 1985:1). The summit is bereft of artifacts or stone structures, and Benedict (1985:11) points to vandalism or erosion as explanations of this deficiency.

In by far the most extensive catalogue of vision quest sites available, Conner (1982) noted that since 1964, "several score" vision quest structures have been recorded in Montana and Wyoming alone. The over 50 such structures he mentions in his article are designated as vision quest sites on the general basis of ethnographic literature for the Crow and various informants' accounts, although the particular assumptions involved in each designation are not given.

All of Conner's structures are oriented essentially east-west. He was told by an informant that a reason for this was that during a vision quest nothing must separate the supplicant from the Northern Star, which is believed to have great supernatural power. The east-west orientation also reflects the importance of the sun as a supernatural power in northern Plains spiritual life (cf. Cooper 1957; Lowie 1922, 1956; Wissler 1912).

In all of Conner's examples, locally available stone was used, with the occasional addition of logs or brush. As well, all of Conner's examples, with one or two exceptions, exhibited a maximum long axis length of under 2 m.

Conner saw two broad, subjective groupings of vision quest structures on the basis of rather ill-defined formal properties. The "traditional" type was never roofed, had walls less than 30 cm in height, and was exclusively oval or U-shaped. The "exotic" type was "coffin-shaped". Walls were higher (less than 1 m) and parallel, usually with a roof of poles or branches and an opening to the east. In some cases, a naturally occurring rock shelter was modified by adding some walls to make such a structure. Conner (1982:120) notes that none of the vision quest structures falling into the "traditional" type can be attributed to a known vision questor, while all of the "exotic" types are of relatively recent (i.e., 20th century) origin, although he is extremely vague as to who created them or when exactly they were created.

This brings us to a phenomenon that must be mentioned, namely, that the vision quest is being practiced in modern times. For example, on the Peigan Reserve in southern Alberta, the vision quest is occasionally done (Eldon Yellowhorn pers. comm. 1984). Dormaar (pers. comm. 1984) has observed offerings of meat, skin pouches, and ribbons at sites in the Sweetgrass Hills. Conner (1982:91-99) gives numerous examples of individuals from the turn of the century onward seeking visions and building vision quest structures.

The revitalization of vision questing has significant implications for the archaeological record, especially when seen in terms of the recorded phenomenon of reuse. It was earlier mentioned that the repeated use of specific vision quest sites is hinted by Wissler (1912:106), Turney-High (1937:27), and Cooper (1957:268). Conner (1982:94) gives the example of an individual repairing and using an existing structure by using rocks from another structure close by. He states that pirating construction material from other vision quest sites is not uncommon in his experience (Conner 1982:97), a thought echoed by Keyser (1979) and Beckes and Keyser (1983). Nowhere in the ethnographic or archaeological literature is it mentioned that individuals had to seek a different site and build his or her own structure. Instead, we get a sense of possible reuse of sites, and occasional reuse of materials within sites.

The very fact that pirating of materials did take place indicates the possible occurrence of two or more vision quest structures in close proximity to each other. This phenomenon is reported by Conner (1982:97, 98, 105, 108, 113), Beckes and Keyser (1983:339-340), Keyser (1979:22), and Wedel (1961:265), with the distances between structures appearing to range from approximately 3 m apart (Conner 1982:105) to about 75 m (Wedel 1961:265). Co-occurrence begs the question of contemporaneity. Structures that are a short distance from each other could have been used at the same time by two separate individuals. An account from a Crow supplicant seems to indicate this possibility:

> We decided to fast there [Where The Thunderbird Sits down Mountain, a peak in the Bighorn Mountains of Montana] because we

> wanted a stronger medicine. Medicine Crow, Young Mountain, Mouse Walks, Shows His Tail, and I were all close friends, but Young Rabbit, Plenty Screeching Owl, and Yellow Weasel were nearly strangers to us ... We arrived at the top before dark and built our little rock piles two feet above the ground ... I asked Young Mountain to help me sacrifice my flesh ... We all stood in a row, raised our sacrifices to the sky, and prayed out loud for a long time ... After the second night five men wanted to return home. I did not think about giving in and let them leave (Nabokov 1967:62-63).

Evidently, eight individuals fasted together, built separate structures, communicated during at least part of the ordeal, but were far enough away not to disturb each others' visions. How this contemporaneity might be manifested in the archaeological record is extremely problematical. In an "ideal" case, two structures made of generally different materials, fairly close together, with some of the stones from one having been used in the construction of the other, probably represent at least two separate vision quest events. Relative dating on the basis of lichen cover (discussed elsewhere in this paper) of the structures, in addition to factors of pirating and distance between structures, might begin to give a more complete, though speculative, history of a vision quest site. One should never ascribe contemporaneity or attempt to disprove it solely on the basis of a "gut feeling" and observed "stylistic" similarities or differences between the structures (cf. Conners 1982:100).

The pirating of structures for the purpose of building others would presumably have the consequence of at least some variability in the resultant structure's size and shape. The measurements given for vision quest structures in this chapter are modal. While a modal size does not necessarily imply an ideal one, it possibly represents, in the case of vision quest structures, the practicality of building a structure large enough for one person to sit or lie in.

One final point concerning the archaeology of vision quest sites is that of related materials and features. I have already mentioned the ethnographic accounts of offerings being brought to vision quest structures and the apparent confirmation of this phenomenon by historical (Wissler 1912:106) and modern (Dormaar pers. comm. 1984) accounts. In addition, there appears to be some evidence of lithic materials possibly associated with vision quest sites, with Reeves (1971) reporting projectile points at one site in Waterton (DgPl-35), and Beckes and Keyser (1983:339) mentioning a moderate scatter of lithics and several artifacts at a Pryor Mountain Vision Quest in Montana. Whether or not the production of such remains was at all related to any vision quest event is unknown - the ethnographic literature is silent on this point.

In terms of other stone features, I know of just two references to stone alignments in the vicinity of vision quest structures. Keyser notes nine irregularly shaped rock structures "L-shaped to crescentic to elongate ... eight feet long by three feet wide" (1979:21-22), near three vision quest structures around the Fresno Reservoir in northern Montana. Conner mentions that "small pebbles had been arranged on the surface of the ground in the southeast portion of the western Castle Rock. One arrangement formed the letters 'PAT', which was the only legible pebble configuration" (1982:102-3). Not much can be said regarding these two instances at this point, but they may be relevant in a discussion of DkPj-21, the Porcupine Vision Quest, presented below.

To sum up the ethnographic evidence, it appears that vision quest structures may be characterized by the following:

1) They are located on topographical eminences with a commanding view of the surrounding area.
2) They may be in the vicinity of a residential encampment of some sort.
3) They are comprised of an elongated stone circle or semicircle, oriented on an east-west axis and sometimes open to the east.
4) They could have been repeatedly used.
5) Offerings of some sort were often brought and left by the supplicant.

Based on at least a few of these criteria, archaeologists have interpreted some sites as vision quest sites. The examples examined in this paper show the following commonalities regarding sites interpreted as containing vision quest structures:

1) The structures are comprised of locally available, dry-laid stone.
2) The modal longest axis seems to be about 1.5-2.0 m long.
3) Structures are often found in close proximity to each other.
4) Material from one structure was frequently pirated to construct other structures.
5) Vision quest structures may be associated with other stone alignments.

Unlike the general appeal to the ethnographic literature or the unstated assumptions of the authors discussed previously in assigning vision quest status to certain sites, the next section will attempt a more rigorous analysis of a particular site - DkPj-21. Such an analysis will hopefuly lend validity to conclusions regarding the appropriateness of assigning vision quest status to DkPj-21.

THE PORCUPINE VISION QUEST SITE: DkPj-21

The Setting

DkPj-21 is located on the top of a high hill (elevation 1325 m) some 2 km north of Head-Smashed-In Buffalo Jump on the eastern edge of the Porcupine Hills in southern Alberta (Figures 146 and 150). A good twenty minute climb from an access road to the west of the site puts one at the summit and affords a spectacular view. To the west, one can see the natural gathering basin for the jump and the Rocky Mountains beyond. To the east is limitless prairie, broken only by the Oldman River valley and the present town of Fort Macleod (Figure 151). In the summer of 1984, the author, under the direction of Jack Brink of the Archaeological Survey of Alberta, mapped, photographed, and test excavated portions of this site.

The Site

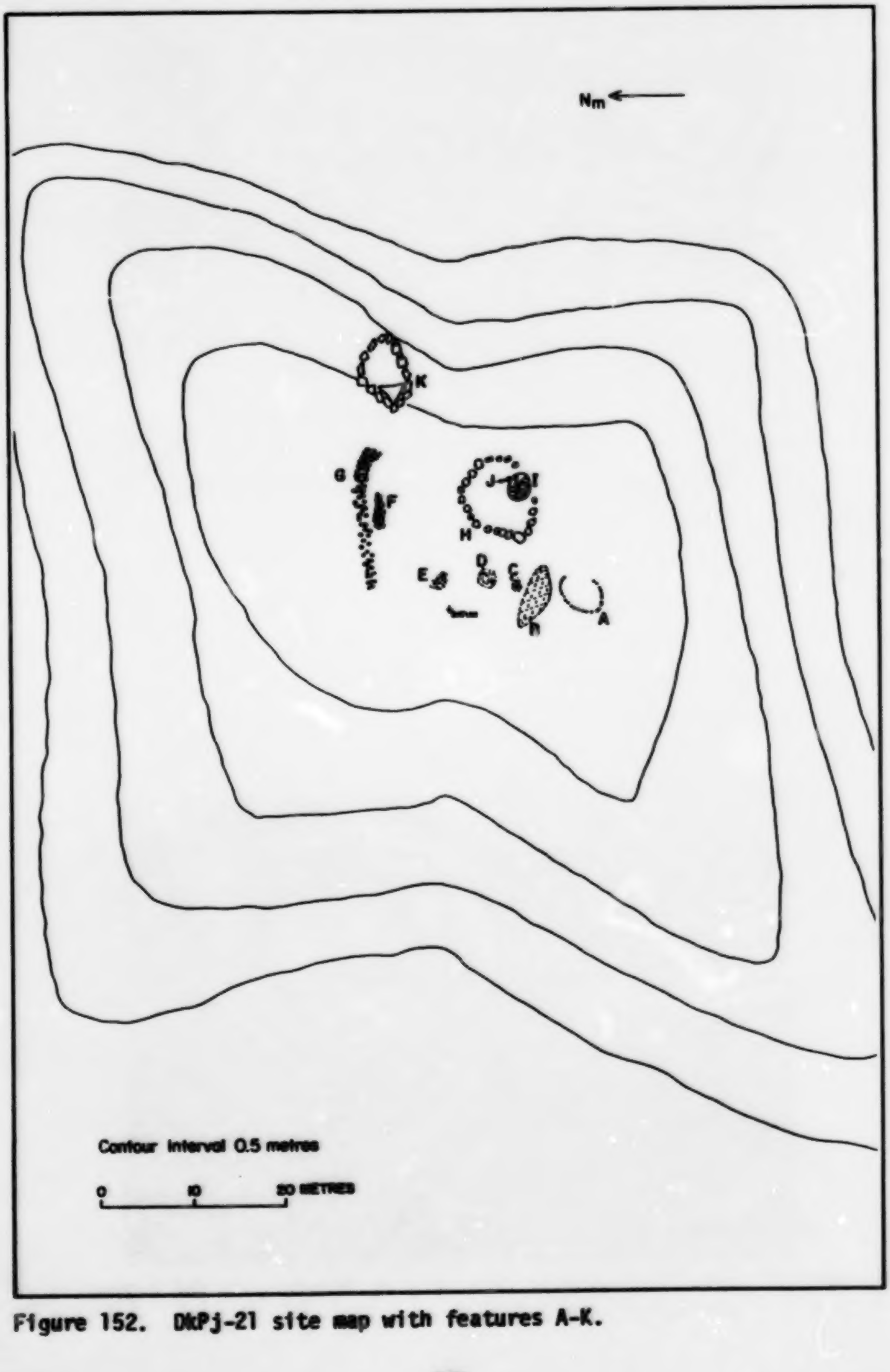
The steep climb levels off to a fairly flat summit, 25 m in diameter (Figure 152). A strong, constant wind from the west has flattened the prairie vegetation cover and exposed outcrops of Paskapoo sandstone and quartzite cobbles just below the summit. The soil is a rocky, brown chernozem with a poorly developed Ah horizon. Slightly embedded in the soil and partially obscured by the flattened prairie grasses are several stone configurations, the general shape and relative positions of which are shown in Figure 152 and described below.

The Structures

On the basis of an observed internal homogeneity, the structures were separated into eleven features. Each feature was drawn using a grid system. Lacking the knowledge of relative dating techniques for lichen cover, the author undertook an impressionistic lichen survey. As well, a

Figure 150. Looking west to summit location of DkPj-21.

Figure 151. View looking east from DkPj-21 (feature I, the cairn, is in the foreground).


Nm
K
G
F
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I
H
D
C
E
B
A
Contour interval 0.5 metres
0
10
20 METRES

Figure 152. DkPj-21 site map with features A-K.

lithology was done. The stones in each feature were typed and sized. It became evident that the most instructive categories of material type related to the differences in morphology between the locally outcropping platey Paskapoo sandstone and the locally available rounded cobbles of other sandstone, quartzite, limestone, siltstone, conglomerate, igneous, and metamorphic rock. The exact lithology, count, and size ranges for the features are shown in Tables 33-36. A description of each feature follows.

Feature A (Figures 153 and 154; Table 33): a small stone circle with an internal diameter of approximately 1.3 m and a large opening to the east. It is comprised of mostly quartzite and limestone cobbles and 71.4% of its constituent stones are between 10 and 25 cm in maximum dimension. Lichen was present on all stones and generally absent on the downwind (eastern) portion of each. As Figure 154 shows, Feature A is heavily covered by vegetation. It is also the most buried feature.

Feature B (Figures 153 and 154; Table 33): a roughly oval shaped structure some 3.4 m long with apparent internal alignments. Lichen was observed on about one third of the stones and the feature did not appear to be deeply sodded in. Approximately 98% of the stones are between 5 and 20 cm in maximum dimension.

Feature C (Figures 153 and 154; Table 33): an 85 cm long teardrop shaped structure. Its lichen cover and degree of imbeddness in the soil are similar to those of Feature B. As well, 100% of its stones are between 5 and 20 cm in maximum dimension. For these reasons, it is probably a part of Feature B.

Feature D (Figure 152; Table 34): a structure 1 m in diameter comprised of an amorphous cluster of smaller stones, clearly distinguishable from the naturally occurring soil clasts present on the hill. Close to 98% of the stones in this structure are less than 10 cm in maximum dimension.

Feature E (Figure 152; Table 34): a small (80 cm in diameter) amorphous cluster of smaller stones only vaguely distinguishable from the surrounding soil. This cluster warranted attention only because it contained a 40 cm wide piece of sandstone with what appeared to be the letters "JLM" scratched into its surface.

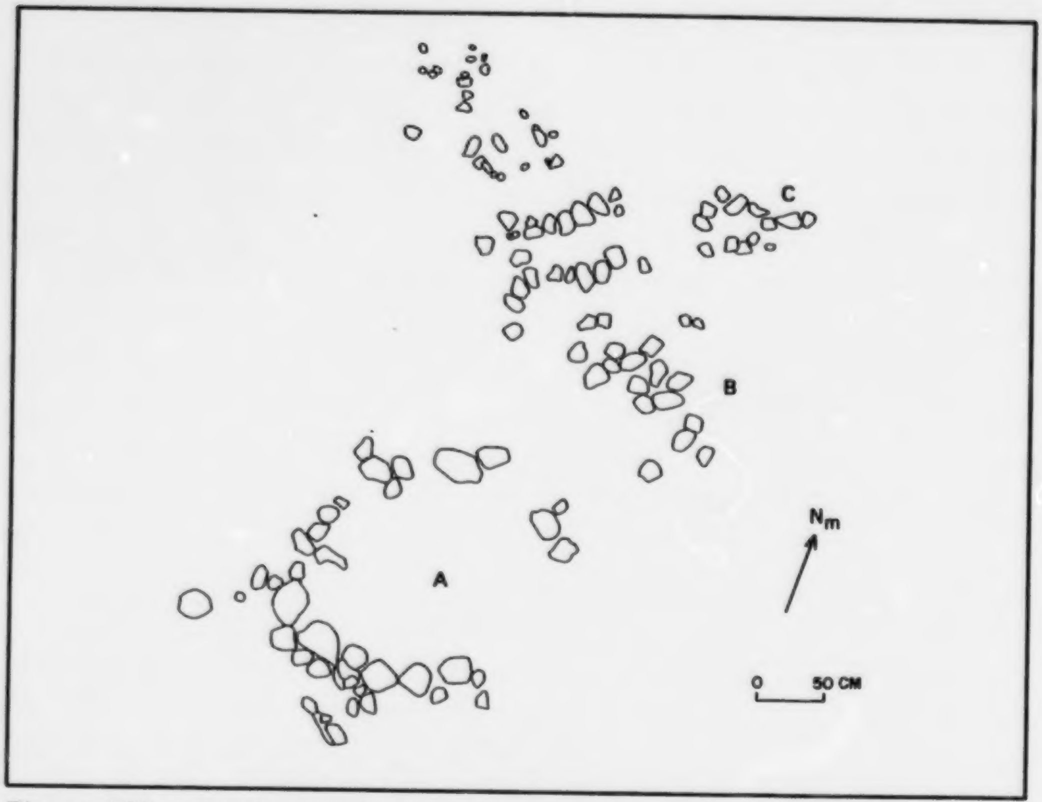

Figure 153. Drawing of features A, B, and C.

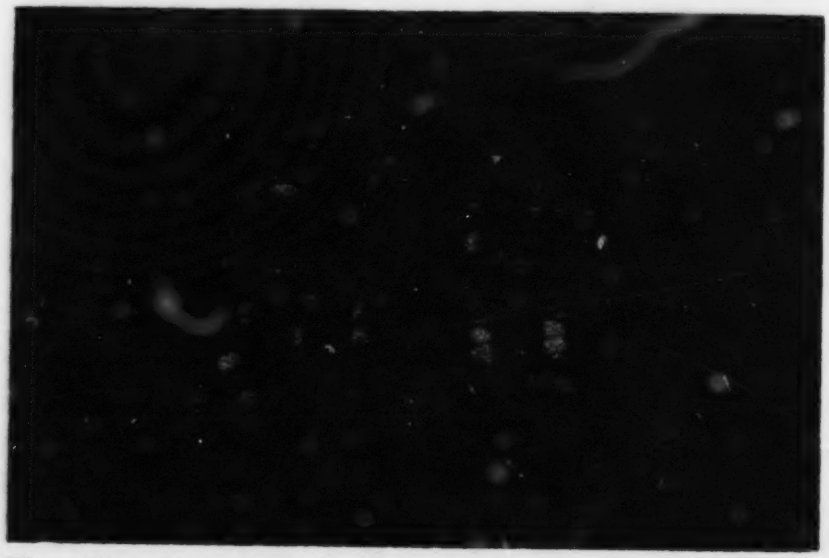

Figure 154. View of features A, B, and C (scale is oriented roughly north-south, view is west).

Table 33. Lithology and size range of features A, B, C.

SIZE RANGE (cm)	MATERIAL TYPE				
	Paskapoo Ss	Other Ss	Quartzite	Limestone	Other*
FEATURE A:					
Indeterminate	1	-	-	-	-
5-10	-	-	1	-	-
10-15	-	1	7	1	-
15-20	2	1	4	4	1
20-25	-	1	2	2	2
25-30	1	-	-	-	1
30-35	-	-	-	1	1
35-40	1	-	-	-	-
n=35	Modal size range: 15-20 cm; 10-25 cm=71.4% of total				
FEATURE B:					
5-10	1	1	7	3	-
10-15	4	2	7	7	1
15-20	2	5	16	3	1
20-25	-	-	-	-	1
n=61	Modal size range: 15-20 cm; 10-20 cm=78.7% of total				
FEATURE C:					
5-10	-	1	1	-	-
10-15	1	2	4	-	1
15-20	-	2	-	-	-
n=12	Modal size range: 10-15 cm; 10-20 cm=83.3% of total				

*Siltstone, conglomerate, igneous, metamorphic, etc.

Table 34. Lithology and size range of features D, E, F.

SIZE RANGE (cm)	MATERIAL TYPE				
	Paskapoo Ss	Other Ss	Quartzite	Limestone	Other
FEATURE D:					
5	-	-	1	4	-
5-10	1	8	27	6	-
10-15	-	-	-	-	-
15-20	-	-	1	-	-
n=48	Modal size range: 5-10 cm; 0-10 cm=97.9% of total				
FEATURE E:					
5-10	-	2	5	4	3
10-15	-	-	1	-	1
15-20	-	-	-	1	1
20-25	-	-	-	-	-
25-30	-	-	-	-	-
30-35	-	-	-	-	-
35-40	1	-	-	-	-
n=19	Modal size range: 5-10 cm; 5-10 cm=73.7% of total				
FEATURE F:					
5	-	-	1	-	-
5-10	-	-	2	-	-
10-15	3	2	7	3	2
15-20	-	1	3	1	1
20-25	-	-	-	-	-
25-30	-	-	-	-	-
30-35	-	-	-	-	-
35-40	1	-	-	-	-
n=27	Modal size range: 10-25 cm; 10-20 cm=85.2% of total				

Feature F (Figures 155 and 156; Table 34): a 1 by 2 m rectangular structure, roughly east-west in orientation with internal alignments. Approximately 85% of the stones are between 10 and 20 cm in maximum dimension.

Feature G (Figures 155 and 156; Table 35): an approximately 7.75 m long by one m wide rectangular structure. Some 99% of the constituent stones are between 5 and 20 cm. Both structures F and G are buried roughly the same amount, that is, not as much as Feature A but more than Features B and C. For this reason and the similarity in constituent stones, Features F and G are probably associated. Moving from west to east in Feature G, it appears that the stones clearly spell out the name "Nelson" and, less clearly, the name "Small Legs".

Feature H (Figure 157; Table 35): the remnants of a roughly 2 m in diameter stone circle with an inner depression oriented east-west. This structure exhibits a widely dispersed size distribution with constituent stones as small as 5 cm and as large as 70 cm in maximum dimension. Also from Table 35, it is evident that there are roughly equal amounts of platey Paskapoo sandstone and rounded cobbles present in the feature.

Feature I (Figure 157; Table 36): a 1 m high cairn of probably recent origin. Figure 151 shows its unstable nature. As well, the lichen cover on the constituent stones is haphazard. The other structures present at DkPj-21 exhibit lichen growth only on the exposed surfaces of the individual stones. The lichen growth on stones in Feature I is present on both exposed and unexposed surfaces, at the center of the cairn and on its periphery. Table 36 shows a large range in the size of constituent stones and roughly equal amounts of platey Paskapoo sandstone and rounded cobbles. It is hypothesized that the stones from Feature H were used in the construction of Feature I.

Feature J (Figures 157 and 158): a quartzite cobble some 20 cm long with a thick piece of weathered, purple, silk-like material tied around it.

Feature K (Figures 159 and 160; Table 36): An oval shaped structure, approximately 1.4 m in internal diameter but over 3 m in diameter measured from its outer edge. It is comprised almost exclusively of Paskapoo sandstone and appears to be built right on an outcrop. The walls are 30 cm high in some places, relative to the internal depression.

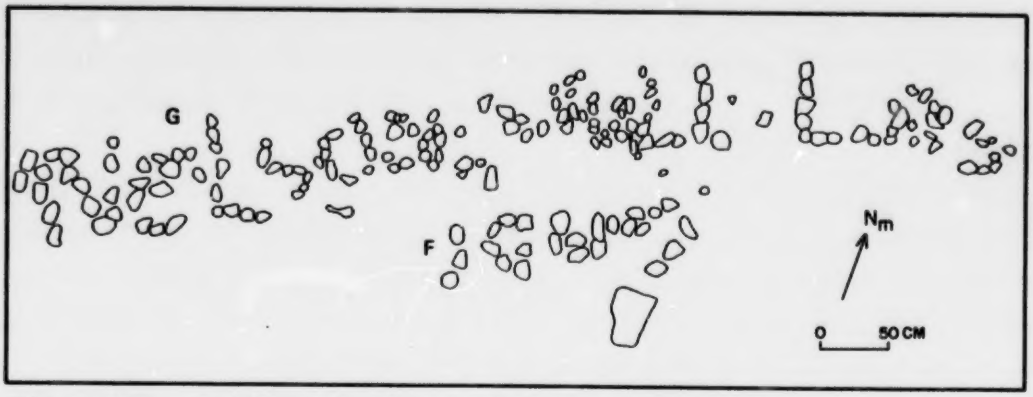

Figure 155. Detailed drawing of features F and G.

Figure 156. View of features F and G (looking west).

Table 35. Lithology and size range of features G and H.

SIZE RANGE (cm)	MATERIAL TYPE				
	Paskapoo Ss	Other Ss	Quartzite	Limestone	Other
FEATURE G:					
5-10	-	15	29	14	3
10-15	-	22	33	8	11
15-20	-	2	6	-	2
20-25	-	-	-	-	-
25-30	-	1	-	-	-
n=145	Modal size range: 10-15 cm; 5-20 cm=99.3% of total				
FEATURE H:					
5-10	1	-	-	-	-
10-15	4	-	3	2	1
15-20	7	-	2	2	-
20-25	3	2	1	-	4
25-30	2	-	1	-	1
30-35	1	-	-	-	-
35-40	1	-	-	-	-
40-45	3	-	-	-	-
45-50	3	-	-	-	-
50-55	-	-	-	-	-
55-60	2	-	-	-	-
60-65	-	-	-	-	-
65-70	1	-	-	-	-
n=47	Modal size range: 15-20 cm; 10-30 cm=74.5% of total				

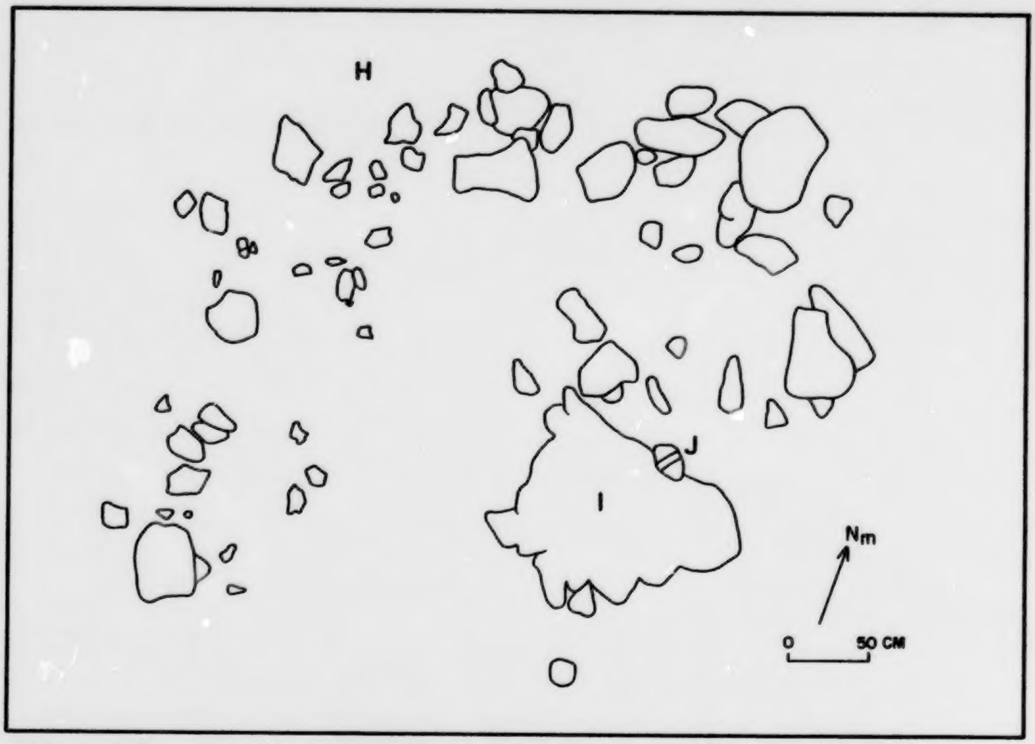

Figure 157. Detailed drawing of features H, I (the cairn) and J (the quartzite cobble with attached silk-like cloth).

Figure 158. View of feature J.

Table 36. Lithology and size range of features I and K.

SIZE RANGE (cm)	MATERIAL TYPE Paskapoo Ss	Other Ss	Quartzite	Limestone	Other
FEATURE I:					
Indeterminate	3	-	6	2	-
5-10	-	-	-	-	-
10-15	1	-	1	-	-
15-20	3	-	2	2	1
20-25	4	-	2	3	2
25-30	4	-	3	-	1
30-35	2	-	-	1	1
35-40	3	-	-	-	-
40-45	1	-	-	-	-
45-50	1	-	-	-	-
50-55	1	-	-	-	-
n= 50	Modal size range: 20-25 cm; 15-30 cm= 54% of total				
FEATURE K:					
Indeterminate	16	-	1	-	2
5-10	1	-	-	-	-
10-15	13	-	2	-	-
15-20	19	-	2	-	-
20-25	19	1	3	-	4
25-30	15	-	1	-	1
30-35	8	-	-	-	-
35-40	15	-	-	-	-
40-45	4	-	-	-	-
45-50	1	-	-	-	-
50-55	1	-	-	-	-
55-60	1	-	-	-	-
60-65	1	-	-	-	-
95-100	1	-	-	-	-
n= 132	Modal size range: 20-25 cm; 10-40 cm=78.0% of total				

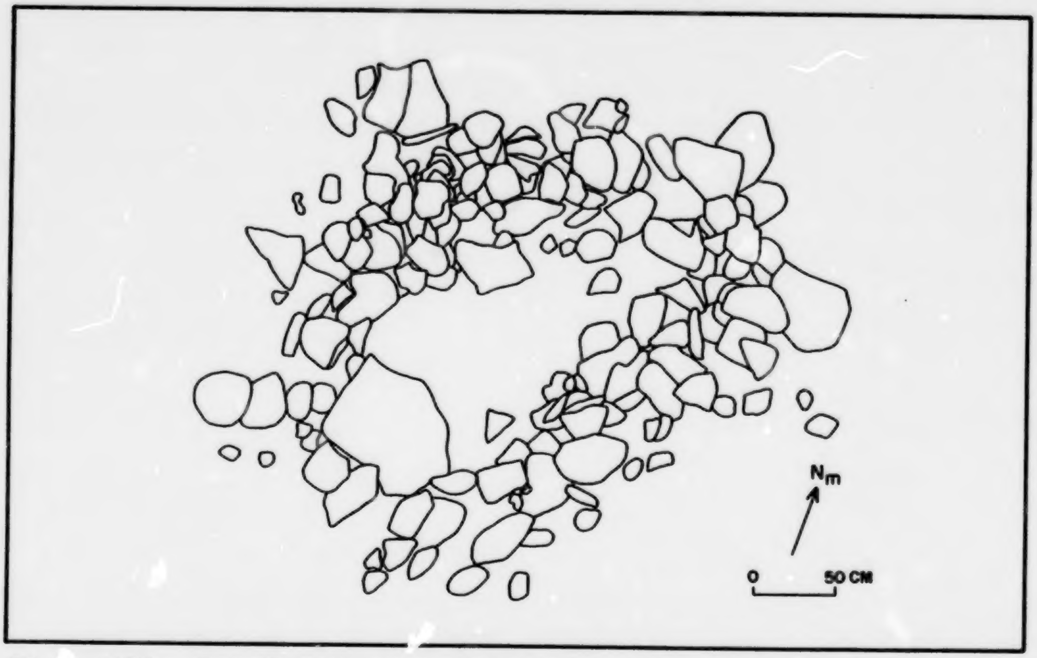

Figure 159. Detailed drawing of feature K (note east-west orientation).

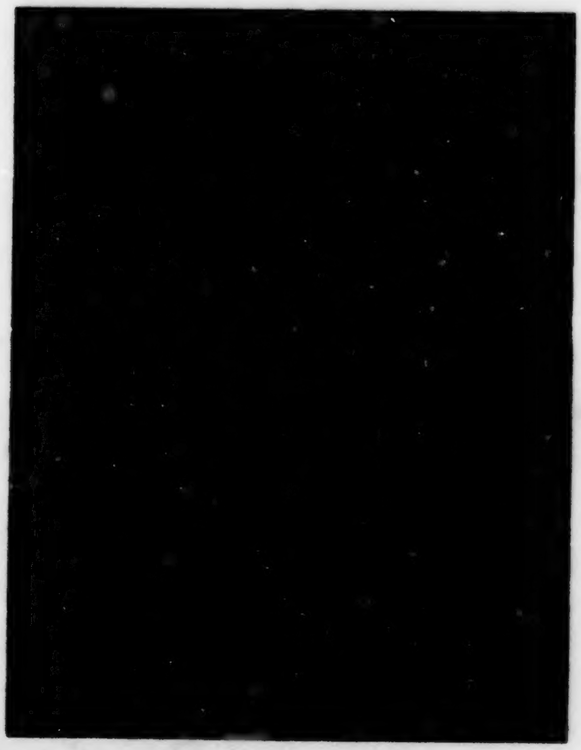

Figure 160. View of feature K (looking east).

Other Features: Other features not shown in Figure 152 include a large sandstone tor, located on the northwestern edge of the summit, with almost indistinguishable incised letters and what appears to be a date "1940"; and a leaf spring from a car or truck, pounded into the ground on the southwestern edge of the summit.

The Artifacts

Two 50 x 50 cm test pits were excavated using a shovel and a one quarter inch mesh screen. Due to the possibility of the site being used by contemporary natives, the test pits were positioned to provide minimum damage to the site. Test pit number one was located in the interior of Feature H, with the reasoning that Feature H had already been surficially disturbed. Test pit number two was located approximately 1 m south of Feature H.

Test pit number one was excavated to a depth of 40 cm, at which point a sterile C horizon was encountered. A summary of the artifacts recovered appears in Table 37.

Two burnt matches were recovered from the first 2 cm, and all 10 pieces of lithic debitage were recovered from the first 10 cm of the test pit. At 22 and 34 cm below surface, two empty pop tins were discovered. A profile of the west wall of test pit number one showed a definite intrusive incident, with a darker, softer matrix characterizing the one in which the pop tins were found (Figure 161).

Test pit number two was excavated to a depth of 30 cm below surface and was completely sterile.

In addition to the two test pits, an intensive surface traverse of the entire summit was conducted by two individuals walking at fingertip distance along a grid. Artifacts were flagged and their exact provenience recorded with a Brunton compass and measuring tape. A summary of the artifacts recovered from the surface traverse appears in Table 38.

The surface traverse produced the majority of artifacts, including three small, unidentified bone fragments, three weathered beer bottle glass fragments, as well as 21 cores, one biface fragment, three retouched flakes, some seven projectile points, and 117 pieces of

Table 37. Artifacts from test pit one.

MATERIAL TYPE	ARTIFACT TYPE Flakes	 Shatter	 Other	 Total	 Depth (cm b.s.)
Chert	5	1	-	6	0-10
Quartzite	-	1	-	1	0-10
Sil. Sandstone	1	-	-	1	0-10
Quartz	2	-	-	2	0-10
Historic	-	-	2 (matches)	2	0-10
			2 (pop tins)	2	20-40
TOTALS	8	2	4	14	-

Table 38. Artifacts from the surface traverse of DkPj-21.

MATERIAL TYPE	ARTIFACT TYPE Flakes	 Shatter	 Cores	 Retouched Flakes	 Bifaces	 Projectile Points	 Other	 TOTAL
Chert	15	25	6	2	1	-	-	49
Chalcedony	-	-	-	-	-	2	-	2
Quartzite	14	20	9	-	-	1	-	44
Obsidian	-	1	-	-	-	1	-	2
Pet. Wood	-	1	-	-	-	1	-	2
Sil. Mudstone	1	-	-	-	-	1	-	2
Sil. Sandstone	5	1	2	1	-	-	-	9
Quartz	3	31	4	-	-	-	-	38
Porcellanite	-	-	-	-	-	1	-	1
Bone	-	-	-	-	-	-	3	3
Historic	-	-	-	-	-	-	3	3
TOTALS	38	79	21	3	1	7	6	155

debitage. A distribution map of lithic artifacts recovered from the surface traverse is shown in Figure 162.

Of the 159 lithic artifacts recovered from the surface traverse and test excavations, only two pieces, both projectile point fragments, were made of exotic material - obsidian and porcellanite. All the rest were composed of cherts, chalcedony, quartzite, petrified wood, siliceous mudstone, siliceous sandstone, and quartz, which are all either local to DkPj-21 itself or local to the Head-Smashed-In area.

It should also be mentioned that 26% of the lithic debitage from the site had a cortex present. This fact, plus the number of cores, suggests that some primary lithic reduction took place at the site at some time.

The seven projectile points, point fragments, and biface fragment are shown in Figure 163. Projectile point A is of the late prehistoric, Prairie Side Notched type. It has a rounded tip and no basal grinding, which indicates it was probably never hafted (Fredlund 1981). It refits with a small, elongated, retouch flake. These facts taken together seem to indicate that this particular point was at least modified and deposited at DkPj-21.

Figure 161. West wall of test pit #1, located within feature H (note the disturbed area in which the pop tins were found).

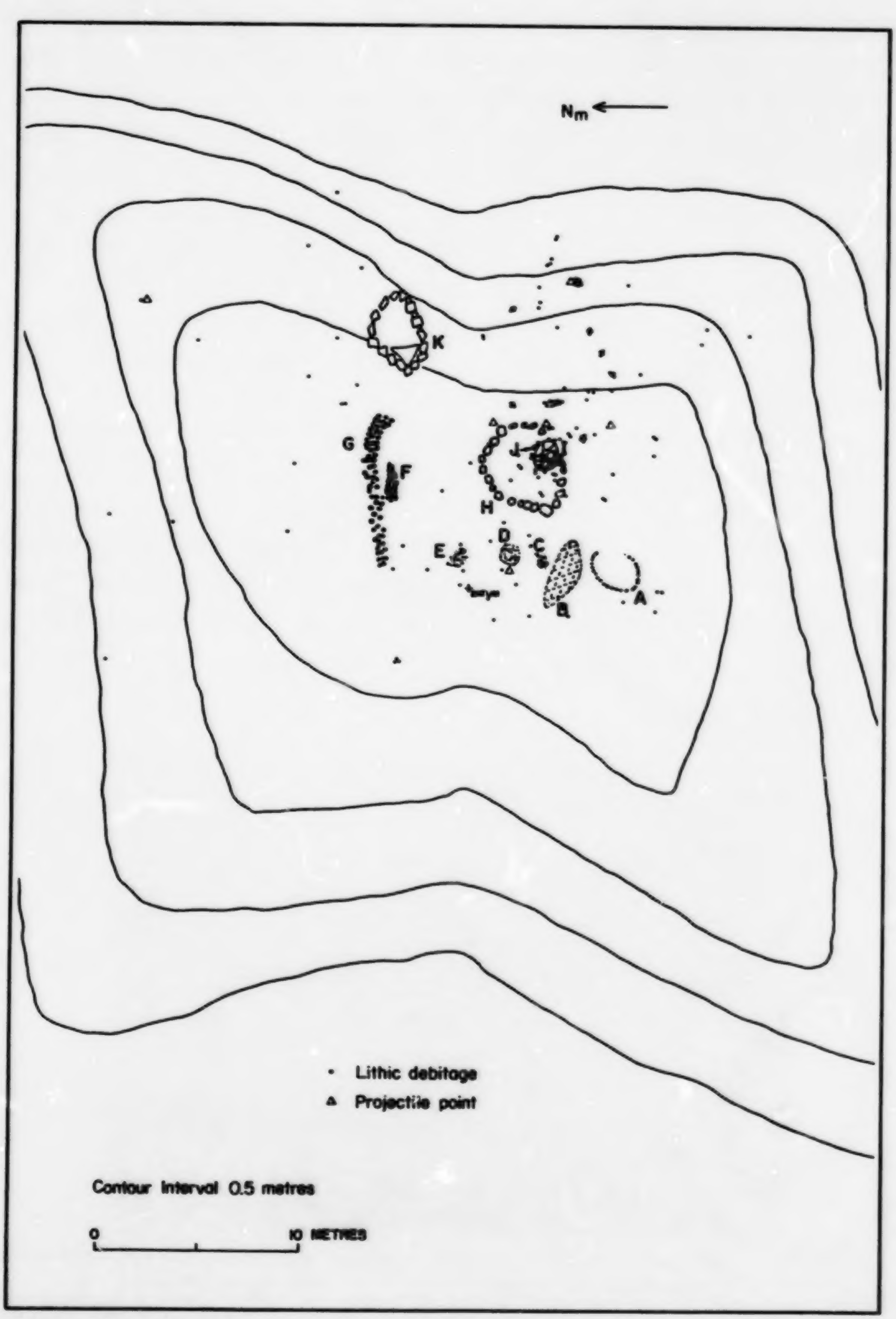
Nm
K
G
F
J
H
D
C
E
B
A
• Lithic debitage
▲ Projectile point
Contour Interval 0.5 metres
0
10 METRES

Figure 162. Distribution of surficial lithic remains at DkPj-21.

Projectile points B,C, and D also show no basal grinding and were therefore probably not hafted as well. Projectile point C is of the Avonlea type, dated to around 1100-1800 years B.P. (Johnson 1970). Artifact E is the tip of a biface. Projectile point G is of indeterminate type, and projectile points F and H are made of exotic (i.e., non-locally available) material - obsidian and porcellanite, respectively. The workmanship of projectile point H is suggestive of Avonlea projectile points.

Discussion

The lithologies (Tables 33-36) indicate an observable size and material homogeneity within each feature. For example, in Feature B (Figure 153, Table 33) 78.7% of the stones are between 10 and 20 cm

Figure 163. Projectile point and biface fragments from DkPj-21. A: late prehistoric, Prairie Side Notched; B: indeterminate type; C: Avonlea; D: indeterminate type; E: biface fragment; F: indeterminate type; G: indeterminate type; H: indeterminate type, suggestive of Avonlea.

long; in Feature G (Figure 155; Table 35) 99.3% are between 5 and 20 cm long; and 81% of Feature K (Figure 159; Table 36) consists of Paskapoo sandstone slabs exhibiting size range from 5 to 100 cm in maximum dimension. In contrast, 97.9% of the stones in Feature D were less than 10 cm in maximum dimension. This fact prompted us to label Feature D a "discard" structure comprised of stones considered too small for use in any of the site structures. Tables 33 through 36 suggest that each structure was constructed with a definite mental template as a guide; collected stones that were too small for constructing a particular structure were possibly tossed together, thus forming the cluster that is Feature D.

The idea of a mental template adds credence to the hypotheses that Features B and C are associated, Features F and G are associated, and that Feature H was pirated to construct Feature I - each of the associated features exhibiting similar constituent stone size ranges and material types.

Thus, the following scenario is suggested: initial construction of Feature H, probably a vision quest structure from its general outline and east-west orientation of its central depression; subsequent pirating of Feature H to construct Feature I, the cairn, in relatively recent times. The recent nature of the cairn is indicated by its already mentioned haphazard lichen cover and generally unstable nature (Figure 151). Perhaps the construction of the cairn is associated with the intrusive event that deposited the pop tins in the depression in Feature H.

It should be mentioned that an attempt to obtain some relative dates for the structures was undertaken. Dormaar (1981) noted that relative dating of stone structures can be done on the basis of the degree of displacement of the B horizon under the stones (due to rainwater flow) of two structures in close proximity which have experienced the same environmental conditions. This technique requires the presence of a well developed brown chernozemic soil, of which there is none at DkPj-21.

Feature K is most probably a vision quest structure. Its shape, orientation, and location are in accord with ethnographic data and other sites that have been interpreted as vision quest sites. Feature K could possibly have existed contemporary with an undisturbed Feature H, or have been an earlier or later construction.

The interpretation of Feature A presents some problems. Although it is located on a high, remote spot and it opens to the east, it is a lot smaller (1.3 m in internal diameter) than both Features H and K, or any of the other probable vision quest structures discussed in this paper (see, for example, Figures 155 - 160). It is possible that the stones were used to hold down a shelter of some kind but the mechanics of erecting a shelter in the almost constant wind at DkPj-21 make this hypothesis improbable. In short, the function of Feature A or its inter-relationships with the other structures at the site are not clear at this point.

The interpretation of Features B and C is also problematic. All that can be said is that they have been constructed with definite ideas as to the size and shape, hence general material type, of the stones to be used. Other sites interpreted as vision quest sites show generally similar stone alignments, but such correlation is unproductive in illuminating the causes of such alignments.

The interpretation of Features F and G proved to be a bit more rewarding. In describing Feature G (Figures 155 and 156) it was noted that it does not take too much of a stretch of the imagination to see that the name "Nelson Small Legs" is spelled out. If this is accepted, then DkPj-21 could have had a memorial function as well.

Nelson Small Legs Jr., the southern Alberta director of the American Indian Movement, committed suicide on Sunday, May 16, 1976 on the Peigan Reserve in southern Alberta. According to the three suicide notes he left, he died in protest of the plight of Natives for the past 100 years and he called for an investigation of the Department of Indian Affairs and the resignation of Judd Buchanan, then Minister of Indian Affairs and Northern Development (The Native People 1976:1; Kainai News 1976:14). His death was reported nationally and Prime Minister Trudeau was forced to comment on its implications (Kainai News 1976:1).

What concerns us here is that the protest death of a prominent local Native leader argues for the interpretation of Feature G as a memorial to Nelson Small Legs Jr. Of course, it is possible that Nelson Small Legs Jr. himself built Feature G, but headlines like "Small Legs Gives His Life for Indian Cause" and "He Died for His People" (Kainai News 1976:1, 14) make the memorial interpretation more tenable. If this is accepted, then Feature F could be the date "1976", having undergone some alteration since then.

An interesting sideline to this interpretation of Feature F and G is the apparent importance of traditional values for modern Natives regarding memorial practices. The articulation of a name written in English and the traditional spiritual importance of a high, remote spot may indicate either an adherence to traditional values or a revitalization of traditional values. Both possibilities lie outside the scope of this paper, however.

It is also interesting to note that Conner (1982:102-3) mentions an arrangement of pebbles near a vision quest structure that spells the name "Pat". Although such a correlation illuminates causation very little, perhaps an expanded survey of vision quest sites would produce more of these "alphabetical structures" and begin to determine how widespread such sites may be. If vision quest sites can serve a memorial function in modern times, then it is possible that they may have served similar purposes in the past. Obtaining conclusive evidence in support of vision quest sites including memorials to individuals in prehistoric or early post-contact times would be problematic at best, but it remains a possibility.

The incised sandstone block in Feature E, the incised sandstone tor, the leaf spring pounded into the southwest portion of the summit, the pop cans, the bottle glass, the matches, the quartzite cobble with the silk-like material tied around it (Figure 158), and the apparent memorial to Nelson Small Legs Jr. strongly indicate the use of DkPj-21 in historic times. The lithic debris suggest the use of DkPj-21 in prehistoric times.

The event(s) of primary and secondary lithic reduction that produced the scattering of artifacts shown in Figure 162 may or may not have been associated with a vision quest event. As mentioned previously, the summit of DkPj-21 affords an excellent view. It is very possible that the summit was used as a lookout for game (such as bison) and that lithic reduction was a time-filler for the individual(s) so engaged.

Although there is no readily discernable pattern in the distribution of artifacts in Figure 162, the majority of them seem to be clustered around Feature H which is on the highest point of land at the summit. If the area around Feature H afforded the best view, it is not unreasonable to assume that lithic reduction while checking for game would go on there as opposed to the area around Feature K, as seems to be the case from Figure 162. If, however, lithic reduction took place during a vision quest event, the clustering of artifacts around Feature H and not Feature K would suggest the greater age of Feature H. Until there is conclusive evidence to suggest that lithic reduction took place during a vision quest as a rule or not, the relative ages of Features H and K on the basis of artifact distribution is just speculation.

Although there appears to be no conclusive evidence to suggest that lithic reduction took place during the vision quest event, there is no conclusive evidence to suggest the contrary either. In fact, the archaeological evidence (Beckes and Keyser 1983; Reeves 1971) discussed earlier may even augment the ethnographic literature by suggesting that lithic reduction was either done: 1) concomitant to a vision quest, i.e., as a time-filler for the supplicant; or, 2) as an integral part of the vision quest event. For example, it was mentioned that self mutilation was sometimes a part of the vision quest. Self mutilation would require sharp instruments for cutting - flakes being one possibility. Similarly, offerings of meat, as reported by Dormaar (pers. comm. 1984) might require cutting tools for preparation. In addition, projectile points themselves may have served as offerings to the supernatural powers sought. The majority of projectile points found at DkPj-21 appear not to have been used, thus lending support to this last point.

Above, I have identified five points that characterize vision quest sites from the ethnographic literature and five points that characterize sites interpreted by archaeologists as vision quest sites from the archaeological literature. It is clear that both sets of criteria apply to DkPj-21.

DkPj-21 is located on a topographic eminence with a commanding view. It probably would have been in the vicinity of residential encampments around the Head-Smashed-In area in prehistoric times. The two probable vision quest structures are (were) comprised of dry-laid, locally available stone - Paskapoo sandstone and quartzite cobbles occur naturally within 10 m of the structures. They are oriented on an east-west axis, and all are between 1.5 and 2 m in diameter. The material from Feature H has been pirated. An apparent offering of cloth and possibly projectile points is present. The vision quest structures may also be associated with other stone alignments.

These conclusions indicate that while DkPj-21 is most probably a vision quest site, all of the associated features and artifacts indicated that it is also not exclusively a vision quest site. With DkPj-21's vision quest status relatively firmly established, it is easier now to deal with two related phenomena that are said to produce similar archaeological manifestations - namely fortification structures and eagle traps.

Fortification structures are best described for the Crow (Conner 1982). Although by no means absolutely clear, Conner comes up with attributes of structures that were used as fortifications in defending against hostile individuals or groups. The fortification structures that Conner is familiar with are large enough to accommodate two or more individuals, even though they may approximate vision quest structures with their circular stone-walled shape. As well, fortification structures are oriented towards the centre, or most secure position of the area being defended, irrespective of the four cardinal directions. Fortification structures also usually occur in groups, allowing individuals to "fall back" to increasingly fortified strongholds. From the above, it is obvious that DkPj-21 cannot be interpreted as including fortification structures.

Eagle trapping was fairly common throughout the Northern Plains. Eagle feathers were highly prized as tokens of wealth and prestige. The process by which eagles were trapped varied from group to group. Most methods involved a depression of some sort in which a hunter would hide and cover himself with brush after baiting the brush with some fresh meat. When the bird landed it was grabbed, probably frantically hung on to, and either killed as soon as possible (Ewers 1958:85) or subdued and ritually killed later (Beckes and Keyser 1983).

It is possible that some vision quest structures may have been used as eagle traps, but two factors make this unlikely: first, high topographical eminences were not always the ideal place to attract an eagle, and second, the actual mechanics of wrestling with such a bird made a shallow depression covered by brush not nearly as practical as a deep pit covered by brush. More specifically, Turney-High (1941:41) notes that the Kutenai waited for eagles soaring over carrion and made their "dugout" nearby. McClintock (1910:428) notes Blackfoot hunters going to an unfrequented spot at the foot of a mountain and digging a deep hole so that one could stand inside, all day if need be. Beckes and Keyser (1983), for the Mandan and Hidatsa, mention that a pit was excavated into the ground in order that the eagle could be pulled in and subdued; ritual prerogatives necessitated the ceremonial killing of it later. It is hard to imagine subduing a golden eagle by pulling it into a 30 cm deep depression along with oneself.

From the above statements, then, it is equally obvious that DkPj-21 was most likely not an eagle trapping site. By stating what DkPj-21 was not, what it may have been has been suggested and we return to the conclusion that DkPj-21 is most probably a vision quest site, but at the same time, not exclusively a vision quest site.

CONCLUSION

This paper has attempted to review the pertinent ethnographic and archaeological literature regarding the vision quest phenomenon on the Northern Plains, and objective criteria for determining vision quest sites have been clarified. On the basis of these criteria, a particular site has been examined and its tentative function as a vision quest site has been affirmed.

Although somewhat unique in the literature, this study has perhaps raised more questions than it has answered. Are many of the sites recorded in the literature erroneously labeled vision quest sites, eagle traps, or fortification structures because of the ambiguity that exists among them? What can be said of the spatial extent of vision quest structures on the Northern Plains? Are more vision quest structures associated with lithic debris and other rock alignments and, if so, what is the nature of this association - is it, as in the case of Nelson Small Legs Jr., a memorial one? Are there more instances of multiple vision quest structures within a particular site and how do variables such as style of structure and physical proximity indicate contemporaneity, if at all? What actually went on during a vision quest event and what may have been the preservable material remains of these activities? And, perhaps most importantly, can archaeological sites be confidently attributed to the ethnographically known activity of vision questing?

By recognizing vision quest structures in the field, and orienting research in the ways outlined in this paper, we can hopefully begin, as this study has done, to address these and other questions regarding the vision quest and vision quest structures on the Northern Plains.

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BIBLIOGRAPHY

Albers, Patricia, and Seymour Parker
1971 The Plains Vision Experience: A Study of Power and Privilege. Southwestern Journal of Anthropology 27(3):203-223.

Beckes, Michael R., and James D. Keyser
1983 The Prehistory of the Custer National Forest: An Overview. United States Forest Service. Washington, D.C.

Benedict, James B.
1985 Old Man Mountain: A Vision Quest Site in the Colorado High Country. Center for Mountain Archaeology Research Report 4.

Benedict, Ruth Fulton
1922 The Vision in Plains Culture. American Anthropologist 24(1):1-23.

1923 The Concept of the Guardian Spirit in North America. American Anthropological Association Memoir 29.

Brink, J.W.
1985 People and Prehistory: Dog Days in Southern Alberta. Paper presented at the Tenth Annual Meeting of the Alberta Archaeological Association, Lethbridge.

Chartkoff, Joseph L.
1983 A Rock Feature Complex from Northwestern California. American Antiquity 48(4):745-760.

Conner, Stuart W.
1982 Archaeology of the Crow Indian Vision Quest. Archaeology in Montana 23(3):85-127.

Cooper, John M.
1957 The Gros Ventres of Montana: Part 2, Religion and Ritual, edited by Regina Flannery. The Catholic University of America Anthropological Series 15.

Dormaar, Johan F.
1981 Effect of Boulderflow on Soil Transformation. In Megaliths to Medicine Wheels: Boulder Structures in Archaeology, edited by Michael Wilson, Kathie Road, and Kenneth Hardy, pp. 31-37. Proceedings of the Eleventh Annual Chacmool Conference. The University of Calgary Archaeological Association, Calgary.

Ewers, J.C.
1958 The Blackfeet: Raiders of the Northwestern Plains. University of Oklahoma Press, Norman.

Fredlund, Lynn B.
1981 Southeastern Montana in the Late Prehistoric Period: Human Adaptation and Projectile Point Chronology. Unpublished Ph.D. dissertation, Department of Archaeology, Simon Fraser University. Burnaby.

Hughes, Christopher J.
1985 The Vision Quest and Vision Quest Structures on the Northern Plains. Honours Thesis, Department of Anthropology, University of Alberta, Edmonton.

Johnson, Ann M.
1970 Montana Projectile Point Types: Avonlea. Archaeology in Montana 11(1):45-58.

Kainai News
1976 Small Legs Gives His Life For Indian Cause. May 31, IX(10):1,14.

Kehoe, Thomas F.
1960 Stone Tipi Rings in North-central Montana and the Adjacent Portion of Alberta, Canada: Their Historical, Ethnological, and Archaeological Aspects. Bureau of American Ethnology Bulletin 173, Smithsonian Institution Anthropological Paper 62:417-474.

Keyser, James D.
1979 Late Prehistoric Period Bison Procurement on the Milk River in North-Central Montana. Archaeology in Montana 20(1):21-22.

Lowie, R.H.
1909 The Assiniboine. Anthropological Papers of the American Museum of Natural History IV(1):1-270.

1922 The Religion of the Crow Indians. Anthropological Papers of the American Museum of Natural History XXV(1).

1956 The Crow Indians. Holt Rinehart and Winston, New York.

1958 The Vision Quest Among the North American Indians. In Reader In Comparative Religion: An Anthropological Approach, edited by William Lessa and Evon Vogt. Row, Peterson and Company, Evanston.

Mandelbaum, David G.
1979 The Plains Cree: An Ethnographic, Historical, and Comparative Study. Canadian Plains Research Centre, University of Regina, Canadian Plains Study 9. Regina.

McClintock, Walter
1910 The Old North Trail or Life, Legends and Religion of the Blackfeet Indians. University of Nebraska Press, Lincoln.

Nabokov, Peter
1967 Two Leggings: The Making of a Crow Warrior. Thomas Y. Crowell Company, New York.

The Native People
1976 A.I.M. Leader Stages Protest Suicide. May 21, 9(1):1-2.

Quigg, J. Michael
1981 Stone Alignments. In Alberta Archaeology: Prospect and Retrospect, edited by T.A. Moore, pp. 59-68. The Archaeological Society of Alberta, Lethbridge.

Reeves, Brian O.K.
1971 An Archaeological Resource Inventory of Waterton Lakes National Park and Preliminary Report for 1971. Unpublished Manuscript on file, Archaeological Survey of Alberta, Edmonton.

Turney-High, H.H.
1937 The Flathead Indians of Montana. American Anthropological Association, Memoir 48.

1941 Ethnography of the Kutenai. American Anthropological Association, Memoir 56.

Wedel, Waldo R.
1961 Prehistoric Man on the Great Plains. University of Oklahoma Press, Norman.

Wildschut, William
1960 Crow Indian Medicine Bundles. Contributions from the Museum of the American Indian, Heye Foundation XVII.

Wissler, C.
1912 Ceremonial Bundles of the Blackfoot Indians. Anthropological Papers of the American Museum of Natural History VII(2).

APPENDIX 2

A Technological and Minerological Assessment of Some Head-Smashed-In Ceramics

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INTRODUCTION

The report that follows is a preliminary investigation of the technological and mineralogical characteristics of seven sherds recovered from the camp site associated with Head-Smashed-In Buffalo Jump. The study is exploratory in that its purposes are, first, to determine whether or not there exists variation in the ceramics and second, to determine if such variation may eventually be correlated with temporal, cultural, or functional factors. Whether or not this avenue of investigation is continued will depend on the results obtained in this analysis.

This study begins with an analysis of the clay sample collected approximately 6 km southwest of the camp site (see Figure 146). The characteristics of the clay are examined using workability tests, water of plasticity, drying shrinkage, and particle size analysis. The results are compared with those of the pottery analysis to determine whether or not the clay deposit may have been utilized by the Head-Smashed-In potters.

Macroscopic and microscopic examination of sherds and thin sections is used to study the technological and mineralogical parameters of the pottery. These analyses provide data on resource selection and manipulation prior to vessel construction, methods of vessel construction, and similarities and differences among the vessels.

CLAY ANALYSIS

Test Results

The tests applied to the clay sample were general workability (Table 39), water of plasticity (Table 40), drying shrinkage (Table 41), and particle size analysis (Table 42).

Workability is a general evaluation of the physical properties of a clay. It evaluates not only plasticity but also other factors that can affect clay behaviour. The tests for bentonite and carbonates are particularly critical because these have severe detrimental effects. Bentonite absorbs excessive amounts of water which, when lost during drying, contributes to extensive cracking and ultimate failure of the vessel. Carbonates decompose during firing, then rehydrate after the vessel cools, expanding in volume and thereby causing vessel failure. Salts leave a drying scum on the vessel surface, a characteristic which is not desirable for glazed vessels (a factor not relevant to prehistoric plains pottery). However, salts can act as deflocculants, thereby improving plasticity. Whether or not prehistoric plains potters were aware of the benefits of salts is unknown.

The clay sample was quite moist when received; consequently, it was quite soft and easily broken. Freshly broken lumps exhibit a platy or blocky structure, indicating alignment of clay particles in the deposit. No bentonite is present, although some salts are. Gritty texture indicates that accessory minerals are present. It was not possible to test for carbonates.

It was difficult to evaluate general workability accurately because of the extremely dry atmosphere (less than 15% humidity) in the archaeology laboratory. A pulverized sample absorbed water very quickly, becoming very plastic to sticky, but then quickly lost its apparent plasticity as water evaporated into the air. This meant that water had to be continually added to maintain plasticity. Once in a plastic state, the clay was easily rolled into a coil which in turn could be twisted into a ring without cracking when it was twisted immediately after forming. If there had been more humidity in the laboratory, the coil could have been twisted more easily and leisurely. The plastic clay was quite firm, for it took some effort to make a depression in it. The clay

Table 39. General workability of clay sample.

Attribute		Results
Odour		musty
Colour		5Y7/3 pale yellow (finely mottled)
Condition		not totally dry greasy feel platy and blocky when freshly broken
Hardness		very soft (easily scratched with fingernail)
Texture		pisolithic, gritty
Bentonite		none present
Impurities:	salt	present (bitter taste)
	organics	rootlets present
	carbonates	could not test for presence
Workability:	absorption	absorbs water quickly
	plasticity	easily rolled into a coil and twisted with minimum cracking
	deformation	slight resistance to deformation, holds shape

Table 40. Water of plasticity of clay sample.

Initial	20%
Final (sticky)	27%

Table 41. Drying shrinkage of clay sample.

Tile #	Initial	1st 24 hr. period	2nd 24 hr. period	3rd 24 hr. period	Loss
1 - weight	50.95 g	50	42.3	41.3	29%
length	100 mm	98	90	90	9%
2 - weight	48.65 g	47.95	40.2	38.95	28%
length	100 mm	97.5	90	90	9%

Table 42. Particle size analysis of clay sample.

Mesh Size	Weight (g)	Weight (%)	Contents
5	0.55	0.6	pebbles (quartzite, silicified sandstone)
10	0.4	0.4	pebbles (quartzite, silicified sandstone)
18	0.455	0.5	pebbles (quartz, silicified sandstone, granite, feldspar, quartzite)
35	1.2	1.2	clay nodules (75%); sand (quartz, feldspar, quartzite, silicified sandstone)
60	2.75	2.8	clay nodules (75%); sand (25%: quartz, feldspar, quartzite, silicified sandstone, concretions)
120	2.50	2.6	clay nodules (50%); fine sand (quartz, feldspar, quartzite, silicified sandstone, concretions)
230	5.25	5.4	extremely fine sand
325	4.30	4.5	clay
"fines"	79.15	82.0	clay
Total	96.55 g	100.0%	
Loss	3.45 g		

retained its shape very well. These are characteristics of a relatively coarse grained clay.

Water of plasticity (Table 40) is a measure of the amount of water that must be added to the clay to obtain optimum plasticity (Lawrence and West 1982:24-25). This is actually a range, with initial plasticity being the point at which the clay first becomes plastic, although it is not yet at optimum plasticity, and stickiness being the point at which optimum plasticity has been exceeded because too much water has been added. The fineness of clay particles is the major factor determining water of plasticity. Fine grained clays may require up to twice as much water as coarse grained clays (Lawrence and West 1982:25).

To test for water of plasticity, 100 g of clay was measured and placed on a glass plate. A 100 cc graduated cylinder was filled with water. Water was slowly added to the clay. The amount of water necessary to develop initial plasticity and stickiness was recorded. Water of plasticity ranged between 20% and 27%, a fairly common range for relatively coarse grained clays (Lawrence and West 1982:25).

Drying shrinkage is an important factor when evaluating clays. Excessive shrinking induces cracking and warping, neither of which is desirable. To determine drying shrinkage, two test tiles were formed and weighed. Two marks 100 mm apart were made on the top of each tile. The tiles were weighed and the distance between the marks was measured over three successive 24 hour intervals (Table 41). The tiles should have been fired, but the lack of a kiln made this impossible.

The linear drying shrinkage of 9% is moderate but not detrimental. The clay did not crack during drying but the tiles did warp noticeably. The dried clay was hard enough that it could not be scratched with the fingernail.

Particle size analysis examines some of the mineral characteristics of clay, in particular, the accessory minerals in the clay. Because coarser fractions tend to reduce plasticity, particle size analysis provides a means not only for evaluating the plasticity of a clay but also for determining what measures are suitable to improve plasticity. Particle size analysis also provides a fingerprint of the clay that can be compared against the clay matrix of sherds. This allows one to determine whether or not the clay might have been exploited by prehistoric potters.

One hundred grams of pulverized clay was mixed with water and washed through a series of eight sieves, the meshes of which correspond to the Wentworth scale of particle sizes (Shepard 1968:118). The slurry that passed through the finest sieve (325 mesh) was strained through filter paper. Each fraction was weighed to determine its proportion of the total sample weight (Table 42).

The 5 to 230 fractions comprise about 17% of the total sample. Of this, about half is undispersed clay nodules. Quartz is the predominant non-clay mineral. Feldspar, quartzite, and silicified sandstone are present in lesser amounts (less than 5% each). Iron concretions appear in the 60 mesh fraction and are most common in the 120 mesh fraction.

The non-clay fraction is sufficient to reduce plasticity slightly. The larger pebbles could be removed during paste preparation; however, the finer fractions could probably not be removed by the prehistoric potters at Head-Smashed-In.

Discussion

These tests indicate that the clay could be used for pottery manufacture, especially where hand-building techniques are used. The clay is not without its problems, but all could be overcome. Aging the clay (letting wet clay stand covered for a few days) will increase plasticity. Adding temper will increase porosity and help reduce some of the drying effects.

If the potters at Head-Smashed-In used this clay, then we should observe the following features in the pottery:

1. The clay matrix should contain about 10-15% non-clay minerals, most of which should be quartz with some feldspar and quartzite visible.
2. These non-clay minerals should vary from subangular to subrounded.
3. Fine iron nodules should be visible (this requires that the pottery was fired to at least 600^0 C in an oxidizing atmosphere).
4. Unmixed clay nodules should be visible.
5. Pottery should have either:
    a. a high proportion of temper, or
    b. large temper particles added to counteract shrinkage and warping tendencies of the clay.

CERAMIC ANALYSIS

Macroscopic Analysis of Forming Techniques

A binocular microscope was used to examine seven sherds from the HSI camp site for evidence of forming techniques. The attributes used in the examination are as follows (see Rye [1981:59-62] for more detailed discussion):

Surface marks: marks left on the vessel during forming. These can include ridges, casts, facets, and drag marks.

Surface finishing: forming techniques that affect surface texture or feel. These include polishing, wiping, burnishing, and smoothing.

Surface deposits: materials or impressions of materials used as parting agents during vessel manufacture. A parting agent is any material used to prevent the clay from sticking to the surface on which it is resting while being worked. It includes sand, ash, matting, fabric, and cord used in conjunction with either primary forming techniques (such as coiling or drawing) or secondary forming techniques (such as paddle and anvil).

Fracture: cracks and breaks observed in vessels or sherds. Three kinds are possible: a) cracks of limited extent; b) oblique or perpendicular edge fracture; c) lamellar fracture parallel to the wall.

Particle orientation: describes the orientation of temper particles relative to vessel surface, i.e., random, partial preferred (partly aligned), preferred (aligned).

Void orientation: a void is a hollow space in the sherd caused by inadequate kneading, incomplete joining of pieces (e.g., coils), or organic inclusions that burn out during firing. Void orientation is described in the same manner as particle orientation.

DkPj-1:40067

Vessel portion: indeterminate body sherd
Vessel shape: unknown
Surface marks:
  exterior: none visible
  interior: none visible
Surface finishing and orientation:
  exterior: smoothed, random orientation
  interior: wiped when leather hard; striations are neat, sharp-edged and randomly oriented.
Surface deposits:
  exterior: indeterminate fabric/twine impressed
  interior: none visible
Variations in wall thickness: 10.9 - 11.4 mm
Fracture: oblique edge fracture
Particle size range: subangular particles between 1-3 mm, poorly sorted
Particle orientation: partial preferred oblique orientation
Void orientation: partial preferred oblique orientation

Drying/firing defects: star cracks (firing) on interior

Discussion: Partial preferred oblique orientation of voids and particles suggests drawing and/or paddling were used as the primary forming technique. After the vessel was formed, or during forming, the exterior was impressed with fabric/twine and subsequently smoothed. The interior was wiped.

DkPj-1:40019

Vessel portion: indeterminate body sherd (possibly neck sherd)

Vessel shape: unknown

Surface marks:

exterior: none visible

interior: none visible

Surface finishing:

exterior: clean sharp-edged striations indicate wiping or scraping when leather hard

interior: extensively smoothed; a few very fine horizontal scratches indicate smoothing was done when clay was leather hard.

Surface deposits:

exterior: none apparent

interior: none apparent

Variations in wall thickness: 9.5 to 10.2 mm

Fracture: vertical to oblique; a few lamellar fractures

Particle size range: predominantly subangular particles, 0.5 to 6.0 mm; not well sorted

Particle orientation: partial preferred oblique orientation

Void orientation: preferred oblique orientation

Drying/firing defects: none

Discussion: Oblique orientation of voids and particles suggests drawing and/or paddling were used as primary forming technique. After forming and when the paste was in a leather hard state, the exterior was wiped vertically and the interior heavily smoothed.

DjPj-1:21016
Vessel portion: indeterminate body sherd (exterior surface exfoliated)
Vessel shape: unknown
Surface marks:
  exterior: not observable
  interior: none
Surface finishing:
  exterior: not observable
  interior: none apparent
Surface deposits:
  exterior: none apparent
  interior: none apparent
Variations in wall thickness: not measurable due to absence of exterior surface
Fracture: sherd edges show both oblique and vertical fractures; lamellar fracture
Particle size range: predominantly subangular particles, 0.5 to 3.0 mm; not sorted
Particle orientation: partial preferred parallel orientation; however, about 30% of particles are randomly oriented.
Void orientation: random to partial preferred orientation, depending on edge examined
Drying/firing defects: spalling (firing defect)
Discussion: insufficient evidence for either primary forming technique or secondary finishing techniques

DkPj-1:3436
Vessel portion: rim
Vessel shape: probably a necked jar
Surface marks:
  exterior: none visible
  interior: none visible

Surface finishing:
exterior: none visible
interior: relatively unsmoothed; a few shallow broad irregular horizontal striations indicate light wiping while clay was in plastic state.
Surface deposits:
exterior: verticle to obliquely oriented fabric or cord impressions
interior: none apparent
Variations in wall thickness: 12.0 to 14.0 mm (lip not measured)
Fracture: perpendicular to oblique edge fracture
Particle size range: angular particles, 0.8 to 3.5 mm; not sorted
Particle orientation: partial preferred oblique to random orientation, depending on edge examined
Void orientation: preferred oblique orientation
Drying/firing defects: none evident
Discussion: incomplete evidence for primary forming techniques. Oblique void orientation implies clay was manipulated by drawing. Paste very lamellar implying clay was not well wedged or bonded by paddling. Fabric/cord wrapped paddle used on exterior. Interior was lightly wiped when clay was plastic. Lip was smoothed and evened by pushing excess clay over exterior angle; this fold was not well smoothed or bonded onto pot exterior.

DkPj-1:40075
Vessel portion: rim
Vessel shape: possibly simple globular or conoidal - no evidence for shoulder
Surface marks:
exterior: none visible
interior: numerous very small depressions, rough (unsmoothed) surface

Surface finishing:
exterior: some burnishing visible below decoration
interior: none visible
Surface deposits:
exterior: none visible
interior: none visible
Variations in wall thickness:
lip: 3.3 to 5.0 mm
below lip: 6.0 to 7.8 mm
Fracture: perpendicular and oblique edge fracture
Particle size range: subangular to subrounded particles, 0.8 to 3.0 mm; not sorted
Particle orientation: random orientation
Void orientation: random to partial preferred parallel orientation (predominantly the former)
Drying/firing defects: none evident
Discussion: Small, irregular depression on interior, rough interior and exterior surfaces, and predominantly random particle and void orientation suggest a pinch pot. The pot was partly burnished on the exterior below the decoration area.

DkPj-1:21035
Vessel portion: rim
Vessel shape: unknown
Surface marks:
exterior: none visible
interior: none visible
Surface finishing:
exterior: obscured by decoration
interior: obscured by cooking deposits
Surface deposits:
exterior: obscured by decoration
interior: obscured by cooking deposits

Variations in wall thickness: 10.0 to 10.3 mm

Fracture: perpendicular to oblique edge fracture

Particle size range: subangular to subrounded particles, 1.0 to 2.0 mm; well sorted

Particle orientation: too few particles to determine existence of orientation

Void orientation: preferred parallel orientation; voids curve toward sherd exterior at lip

Drying/firing defects: none visible

Discussion: Surface evidence for primary forming techniques either not apparent or obscured by decoration and cooking deposits. Parallel void orientation suggests pot was formed by drawing and/or paddling. Lip was formed by folding clay to outside of vessel and then smoothing it.

DkPj-1:40073

Vessel portion: rim

Vessel shape: perhaps a simple globular shape

Surface marks:

exterior: none visible

interior: none visible

Surface finishing:

exterior: Smoothing has partially obliterated fabric impressions. A few shallow short horizontal scratches may be accidental rather than intentional finishing.

interior: A few shallow short horizontal scratches may be accidental rather than intentional finishing.

Surface deposits:

exterior: coarse fabric impressions

interior: nothing visible

Variations in wall thickness:

lip: 10.3 to 10.6 mm

below lip: 9.6 to 11.3 mm
Fracture: perpendicular and oblique edge fracture
Particle size range: predominantly subangular particles 0.8 to 6.4 mm; not sorted
Particle orientation: random orientation
Void orientation: random orientation
Drying/firing defects: none evident
Discussion: Random void and particle orientation suggest pinching was used as a primary forming technique and that paddling (a secondary forming technique) was not well executed.

In summary, four vessels (nos. 40067, 40019, 3436, and 21035) were probably formed by using drawing as a primary forming technique and paddle-and-anvil as a secondary technique. Two vessels (40075 and 40073) were formed by pinching clay into shape, one of which (40073) was then poorly paddled. The forming techniques used for the seventh vessel (21016) cannot be determined from the sherd.

It should be emphasized that these conclusions about forming techniques are only tentative because of the very limited nature of the sample from each vessel. Ideally, one should have several sherds from different parts of the vessel and, preferably, reconstructed segments. Different attributes may be more readily observed on different parts of a vessel. For example, drying or firing cracks are most likely to occur where there are sharp changes in either curvature or thickness. A large sample also permits one to distinguish between regular and idiosyncratic procedures within a potting community. However, in spite of the limited sample, there is nothing in the sherds that obviously distinguishes them from the general standard of late prehistoric, and in particular, Old Women's phase, pottery.

Microscopic Analysis

Standard thin sections of each sherd were examined under a polarizing microscope. Minerals were identified and quantified. Particle size analysis of grains larger than 1/16 mm was conducted. The results of the particle size analysis were used to calculate minimum and maximum estimates of temper proportions. Two sections were prepared from each sherd to examine variation in temper minerals, particle size range, and temper estimates within a vessel.

The results of the mineralogical analysis are presented in Tables 43 and 44. The results of both technological and mineralogical analyses are summarized in Table 45.

Four different clays are present in the sample (Table 45). One clay (vessels 3436 and 21035) contains a high proportion of accessory minerals (about 25%). A second clay (vessels 40067 and 40019) contains a moderate amount of accessory minerals (16 to 19%). The third clay (vessesl 40073 and 21016) is a micaceous clay with about 10% accessory minerals. The fourth clay (vessel 40075) is non-micaceous and contains about 10% accessory minerals. The paste in this vessel exhibits pleichroism as a unit, suggesting the clay particles are highly aligned.

The minimum and maximum temper estimates can vary greatly between sections of a single vessel. This is due to two factors. One is the unsorted nature of the temper particles. Only one vessel (21035) contains temper particles that fall within a narrow range (1.0 to 2.0 mm) (Figure 164); the minimum and maximum temper estimates did not vary greatly between sections (Table 44). Particle size of all other vessels ranges from less than 1 mm up to 6.4 mm, suggesting little care was taken in preparing the temper (Figure 164). The author has found in early experiments that it is easy to remove large temper particles simply by brushing over the surface of the grit pile. Pieces larger than 2.0 mm can be brought to one side and discarded relatively easily.

In spite of the variation between sections of a vessel, the temper ranges appear to fall into two categories: lightly tempered (2 to 10%:Figure 165) and heavily tempered (12 to 26%:Figure 165). There is no correspondence between the amount of temper added and the type of clay used. This lack of correspondence may be due to factors such as small sample size, vessel size, wall thickness, and vessel function.

The second factor is inferred more than observed and that is that the clay-temper mixture was not well wedged prior to vessel construction. This means that temper particles would not be evenly distributed throughout the paste, a feature observed in several sections (Figure 166).

Table 43. Clay (matrix) and non-clay mineral components by percentage composition from paired samples.

Sample Number	Matrix	Unidnntified (feldspar/ quartz	Biotite	Calcite	Chlorite	Hornblende	Magnetite	Microcline	Microperthite	Muscovite	Myremkite	Olivine	Plagioclase	Quartz
40067-1	84.3	7.1	.1	-	.4	*	-	.3	*	*	-	-	7.8	-
40067-2	80.4	15.7	.1	-		*	-	1.8	*	*	.8	-	.3	.2
Mean	82.4	11.4	.2		.5			1.1			.4		4.1	.1
S	2.759	5.304	1.41		.1			1.063			.566		5.304	.141
40019-1	82.9	14.9	.5	-	.3	-	-	.6	-	*	-	*	.6	.2
40019-2	76.1	19.2	1.2	-	1.2	.6	-	.3	-	*	-	*	.5	.9
Mean	79.5	17.1	.9		.8	.3		.5					.6	.6
S	4.808	3.041	.5		.64	.424		.224					.1	.5
21016-1	85.3	10.8	1.1	-	.2	*	-	1.6	-	-	-	-	1.0	*
21016.2	89.3	7.1	.6	-	.3	*	-	.3	-	.2	-	-	2.2	*
Mean	87.3	9.0	.9		.3			1.0		.1			1.6	
S	2.828	2.617	.361		.1			.922		.141			.849	
3436-1	55.1	35.6	1.1	-	1.5	-	*	-	1.1	*	*	2.4	2.9	.3
3436-2	69.1	21.0	.8	-	.8	-	*	-	5.1	*	*	.3	1.0	1.9
Mean	62.1	28.3	1.0		1.2				3.1			1.4	2.0	1.1
S	9.899	10.324	.224		.5				2.828			1.487	1.345	1.131
40075-1	72.8	11.0	3.4	-	.6	-	*	2.5	-	-	-	-	9.1	.6
40075-2	72.6	13.1	2.4	-	1.9	-	*	1.8	-	-	-	-	7.7	.5
Mean	72.7	12.1	2.9		1.3			2.2					8.4	.6
S	.141	1.487	.707		.922			.5					.99	.1
21035-1	77.8	14.3	.6	-	2.7	.8	.2	-	-	-	-	2.4	.7	.5
21035-2	78.9	14.4	1.1	-	1.2	1.3	.2	-	-	-	-	2.5	.3	.1
Mean	78.4	14.4	.9		2.0	1.1	.2					2.5	.5	.3
S	.781	.1	.361		1.063	.361	0					.1	.283	.283
40073-1	68.0	15.3	1.4	.5	-	*	*	1.2	-	2.7	-	*	10.7	.2
40073-2	66.3	20.6	.9	5.4	.1	*	*	.7	-	.5	-	*	5.3	.2
Mean	67.2	18.0	1.2	3.0	.1			1.0		1.6			8.0	.2
S	1.204	3.748	.361	3.466	.1			.361		1.556			3.818	0

*observed but not counted
S - standard deviation

Table 44. Size distribution of non-clay minerals and estimated temper percentage for paired sherd samples.

Sample		Size in mm^2					Estimate of % Temper	
		1/16 mm	1/4 mm	1/2 mm	3/4 mm	1 mm	Min	Max
40067	Sherd 1	27.7	24.0	5.1	2	41.2	6.8	11.4
	Sherd 2	35.7	9.4	6.7	0	48.2	9.4	12.6
40019	Sherd 1	81.0	7.0	0	2.4	9.5	2.0	3.2
	Sherd 2	74.6	6.7	1.2	3.6	14.0	4.5	6.1
21016	Sherd 1	59.1	18.2	3.2	19.5	0	3.3	6.0
	Sherd 2	8.3	23.1	23.1	0	45.4	4.8	9.8
3436	Sherd 1	40.7	1.8	1.6	.6	55.3	25.1	26.6
	Sherd 2	60.4	1.2	2.2	2.2	34.0	12.3	12.3
40075	Sherd 1	45.6	10.7	10.7	18.1	14.9	14.8	14.8
	Sherd 2	16.5	7.2	8.7	8.7	58.8	22.9	22.9
21035	Sherd 1	63.3	8.3	5.4	2.9	20.1	5.1	8.1
	Sherd 2	68.4	8.5	3.7	2.9	16.5	4.1	6.7
40073	Sherd 1	39.0	11.0	9.2	13.8	27.0	16.0	19.5
	Sherd 2	30.7	7.1	4.5	4.9	52.8	21.0	23.3

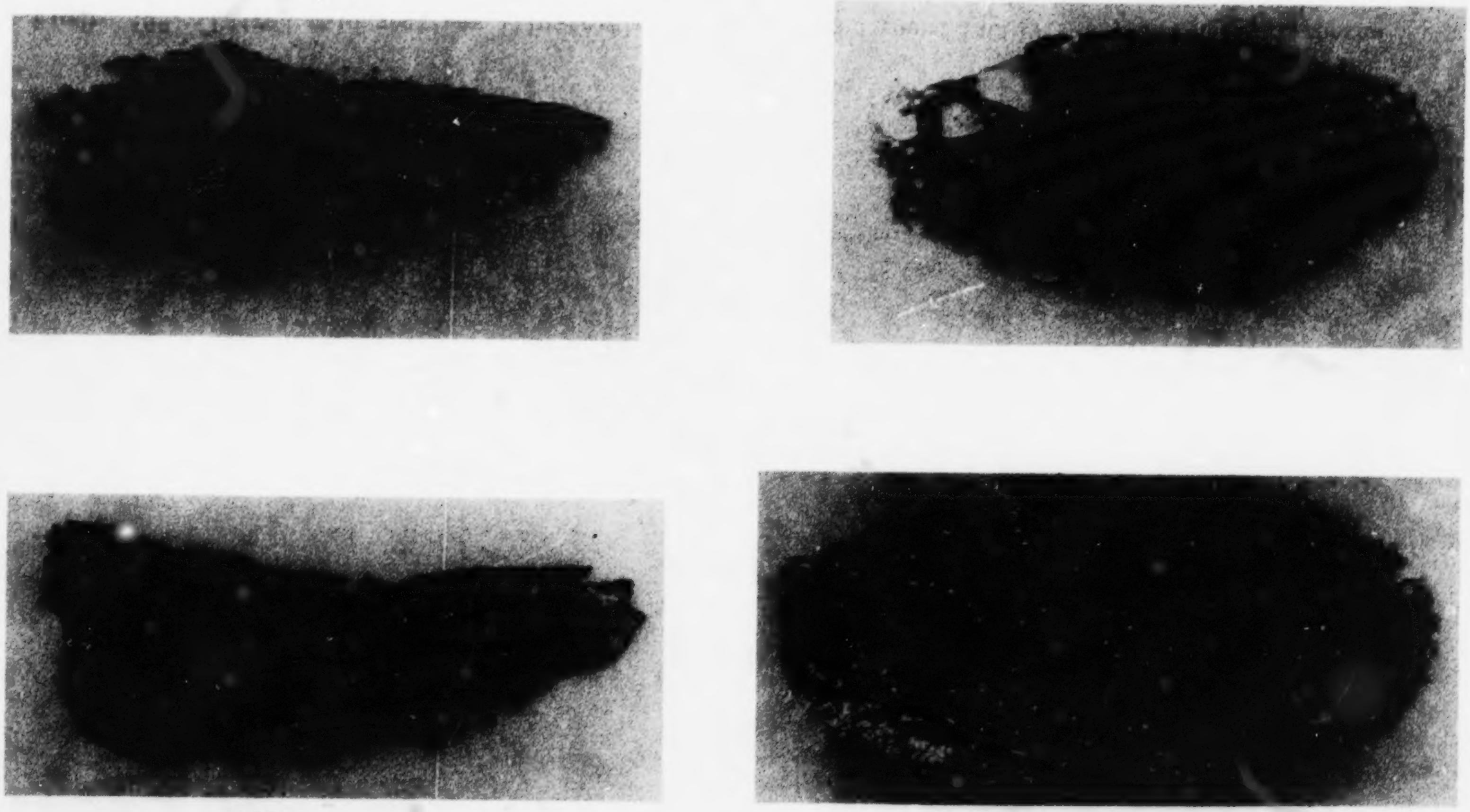
There appear to be two preferred temper materials. The tempering minerals observed in five vessels (40067, 40019, 21016, 40075, and 40073) are predominantly feldspars (which, when identifiable, are usually plagioclase, occasionally microcline, microperthite, and myrmekite), with quartz, biotite, chlorite, and hornblende in lesser quantities. These are minerals found in granite and gneiss. The remaining two vessels (3436 and 21035) contain high proportions of olivine. An olivine gabbro may have been the source.

DISCUSSION AND CONCLUSIONS

One clay sample and seven sherds have been analysed as a preliminary examination of the technological and mineralogical variation that exists in the ceramic assemblage at the Head-Smashed-In Buffalo Jump site. The

Table 45. Summary of forming and technological attributes.

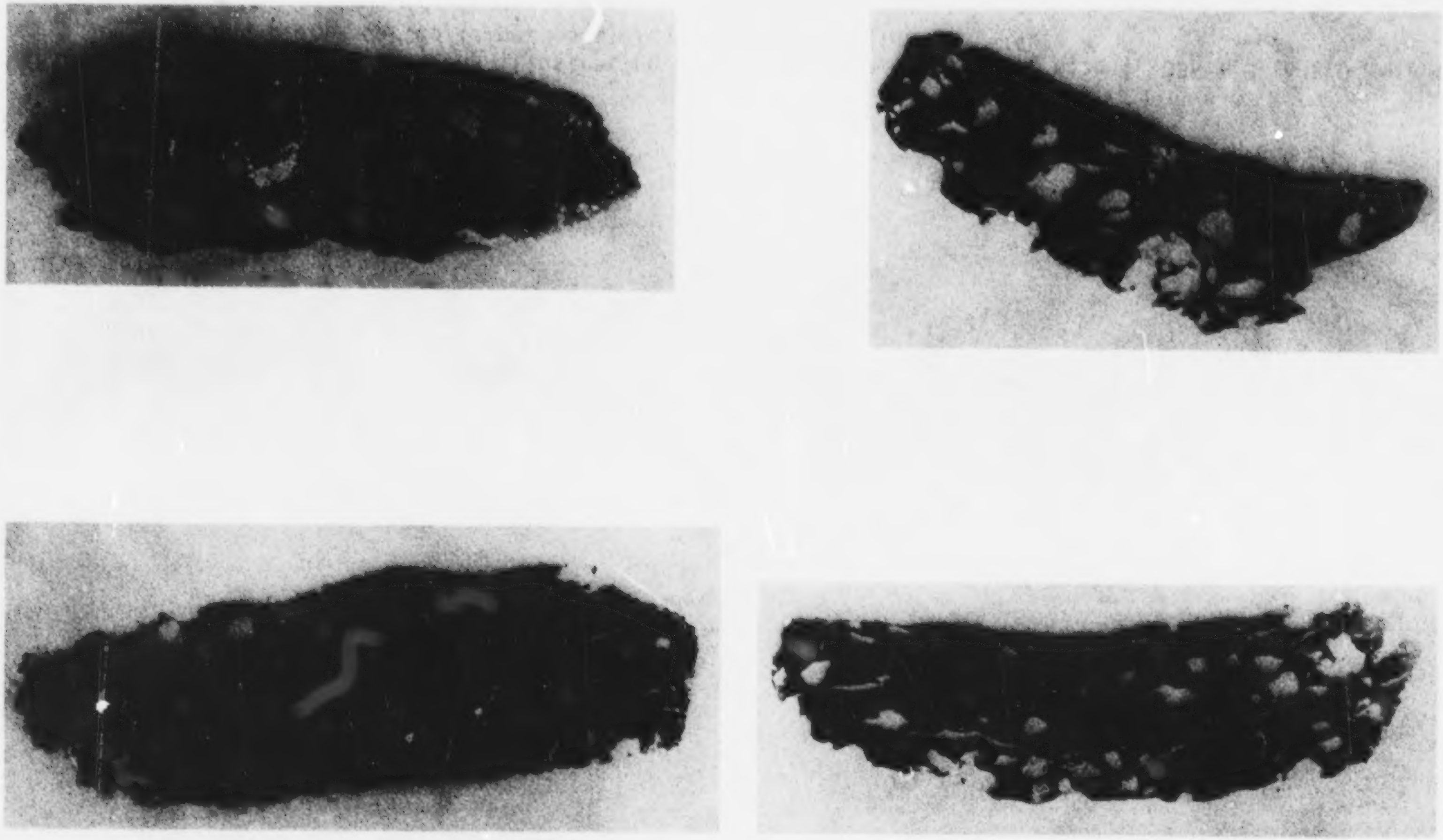
Sherd No.	Surface Finish	Forming Technique(s)	Particle Size Range	% Temper	Temper Source(s)	Proportion of Accessory Minerals in Clay
40067	fabric-impressed; smoothed	drawing paddle & anvil	1.0-3.0 mm	6-12%	granite gneiss	19%
40019	smooth	drawing paddle & anvil	0.5-6.0 mm	2-6%	granite gneiss	16%
21016	N/O	unknown	0.5-3.0 mm	3-10%	granite gneiss	9%
3436	fabric-impressed	drawing paddle & anvil	0.8-3.5 mm	12-26%	olivine gabbro	26%
40075	smoothed; burnished	pinch	0.8-3.0 mm	14-26%	granite gneiss	9%
21035	N/O	drawing paddle & anvil	1.0-2.0 mm	4-8%	olivine gabbro	23%
40073	fabric-impressed	pinch paddle & anvil	0.8-6.4 mm	16-23%	granite gneiss	13%



21035

40073

Figure 164. Paired thin sections illustrating well sorted temper particle size (21035:1.0 to 2.0 mm) and poorly sorted temper particles (40073)-Magnification = 4x.


40019

40075

Figure 165. Paired thin sections illustrating light tempered sherd (40019:2-6%) and heavy tempered sherd (40075:14-26%; Magnification 4x).

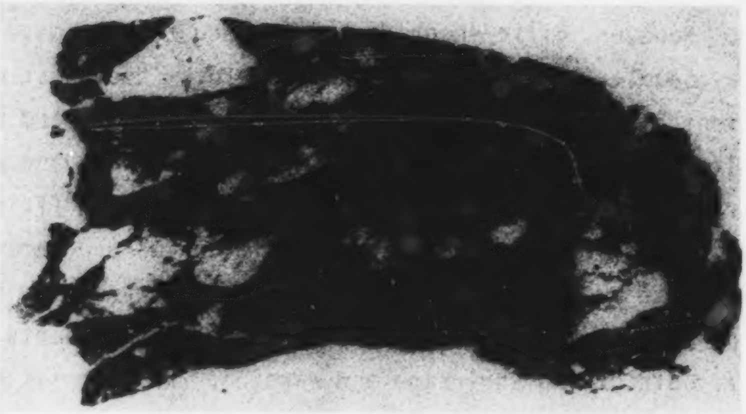


Figure 166. Thin sections illustrating unevenly distributed temper particles in paste (note that upper section contains more temper particles than lower; Magnification 4x).

limited sample means that results can in no way be considered conclusive. However, differences do exist among the sherds.

The clay sample, taken from a source some 6 km southwest of the site, has sufficient plasticity and strength to be usable for hand built pottery. Its main deficiencies are the drying shrinkage and the tendency to warp during drying. The behaviour of the clay during firing has not been tested. However, all the observed deficiencies are marginal and could be overcome by experienced potters. Plasticity can be improved by aging the clay or by adding dung. Adding appropriate amounts of temper can minimize both drying shrinkage and warping. What constitutes an "appropriate amount" of temper must be determined experimentally for each clay source.

The attributes that would be seen in Head-Smashed-In pottery IF potters had used that clay were outlined above. These were:

a. The clay matrix should contain 10 to 15% accessory minerals, predominantly quartz with some feldspar and quartzite.
b. Accessory minerals should be subangular to subrounded.
c. Fine iron nodules should be visible.
d. Unmixed clay nodules should be visible.
e. The sherds should contain either a high proportion of temper or large temper particles.

The matrix of two sherds (40067 and 40019) meets these criteria. These sherds contain 16 to 19% accessory minerals in the clay that are either quartz or feldspar. Because of their small size, it is impossible to distinguish between quartz and feldspar except for those feldspar particles that exhibit distinctive twinning patterns. These particles are usually subrounded, although the large ones can be subangular. Both oxidized iron nodules and clay nodules were observed in the paste. Both sherds are in the lightly tempered category, but temper particles are fairly large (up to 6.0 mm). In other words, the analysed clay deposit OR one that developed from similar parent material under similar conditions could have been used to make some of the vessels at Head-Smashed-In, but not all of them.

Three other sherds have similar proportions of accessory minerals but there are sufficient differences to suggest they were not made of the Head-Smashed-In clay sample. Two other sherds (40073 and 21016) comprise matrix with 9 to 13% accessory minerals. However, both of these clays contain a high proportion of mica, which is not present in the clay sample. A third sherd (40075) contains no visible clay nodules or oxidized iron nodules.

It appears that three clay deposits were used in addition to the clay source found near Head-Smashed-In. One deposit contains a very high proportion of accessory minerals (23-26%); one is micaceous clay containing 9 to 13% accessory minerals, and one contains a low proportion of accessory minerals (9%). It is impossible to say if these clays are from the Head-Smashed-In area or if they represent pots (or clays brought in from "outside". Our knowledge of the distribution and varieties of clays in the region is inadequate. Furthermore, we know nothing of the criteria prehistoric potters used to select and prepare clays, or of the extent to which they carried pots with them from site to site. Consequently, we can say only that at least four clays were used in the production of some of the vessels left behind at the Head-Smashed-In camp, only one of which is probably local. The sources of the others are unknown.

This apparent pattern of clay selection seems to be cross-cut by two tempering patterns and two preferred temper sources. There are both lightly temepred (2% to 10%) sherds and heavily tempered (12 to 26%) sherds. The temper source for most sherds is granite or gneiss, but two vessels appear to have been tempered with olivine gabbro.

There is no obvious correlation of forming technique, clay source, temper source, temper amount, or location within the site. This is not surprising, given the sample size. Nevertheless, the results clearly indicate that potters camping at Head-Smashed-In had a variety of clay sources and temper sources from which to choose and followed at least two patterns of vessel forming and tempering. Evidence from contemporary potting communities indicates that "primitive" potters are very conservative in their habits (Foster 1965:47). Consequently, it is probable that this variation at Head-Smashed-In represents not capricious behaviour but rather definite potting technologies used by the potters to produce functional vessels from available resources.

RECOMMENDATIONS FOR FUTURE RESEARCH

The analysis indicates that there is technological variation among the Head-Smashed-In vessels in both raw material selection and vessel manufacturing techniques. In order to determine the factors underlying this variability, the following problems could be investigated:

1. the source of raw materials, particularly clays. The Head-Smashed-In potters used at least four clays. The region surrounding the site should be examined to locate clay deposits which can be sampled and analysed so that their characteristics can be compared to the pottery. Particle size and thin-section analyses would be adequate. Chemical analysis (e.g., ICP plasma analysis, neutron activation analysis) would provide more powerful means of correlating clays and ceramics but would require the analysis of sherds as well as of clays.

2. the validity of the perceived "light" and "heavy" tempering patterns. At least three factors may be implicated: an attempt to compensate for clay deficiencies, functional requirements of vessels (e.g., cooking versus storage), and vessel size.

3. change and stability in ceramic manufacturing. If differences are noticed that do not appear to correlate with functional or other technological parameters, it might be possible to use these variations, in conjunction with other artifactual data, to postulate the existence of local groups and to delimit their territories.

A very important consideration before proceeding with such research is whether or not the ceramic samples meet certain conditions of size, temporal control and cultural associations. These criteria are important if we want to examine, with any reliability, the range and limits of variability of each factor in the assemblage.

The first condition is that the sherds can be assigned both temporal and cultural associations, two factors that can contribute to perceived variability. Good temporal and cultural control represents one of the major difficulties at the Head-Smashed-In camp site. Soil deposition has been retarded by erosion and deflation; consequently, the entire cultural sequence is compressed (or collapsed) into 20 to 30 cm. In addition, the camp area has been intensively used. Discrete features and activity areas are rarely discernable (Brink et al. 1984:28). There is some suggestion of horizontal separation of cultural deposits, but materials are sufficiently mixed that "it is possible to recover a Besant point, a sherd and a trade bead, all [in] the same level!" (Wright, pers. comm. 1985).

If future investigations at the camp site can delimit temporally and culturally distinct areas, those possible effects on change or stability in technology can be controlled for. Otherwise, the ceramics will have to be treated as a mixed assemblage. This means that there would be a larger proportion of apparently random variation that could not be explained.

A second condition is better vessel representation. Head-Smashed-In ceramics consist predominantly of comminuted sherds weighing less that 2 g which are sparse and widely scattered (Brink et al. 1984:33). This makes vessel reconstruction almost impossible. Observations on vessel size, shape, construction techniques, and function are most reliable when based on reconstructed segments. Having only single sherds limited our ability to observe and interpret technological variability.

A third condition is a sufficiently large sample size to determine if variation is random or patterned, i.e., related to actual technical or functional parameters. To date, few sherds meet the minimum criterion of size to be included in the sample.

In conclusion, the ceramics at Head-Smashed-In present some very interesting questions about technology and cultural context. This initial investigation has suggested the scope of the problems that may be investigated. The decision as to whether or not to continue should be based on the ability to acquire an adequate sample for analysis.

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BIBLIOGRAPHY

Brink, Jack, Milt Wright, Bob Dawe, and Guy Trott
1984 Preliminary Report on the 1983 Field Season at the Head-Smashed-In Buffalo Jump, Alberta. In Archaeology in Alberta, 1983, compiled by D. Burley, pp. 16-44. Archaeological Survey of Alberta, Occasional Paper 23. Edmonton.

Foster, George M.
1965 The Sociology of Pottery: Questions and Hypotheses Arising from Contemporary Mexican Work. In Ceramics and Man, edited by F.R. Matson, pp. 43-61. Aldine, Chicago.

Lawrence, W.G., and R.R. West
1982 Ceramic Science for the Potter (2nd edition). Chilton.

Rye, Owen S.
1981 Pottery Technology: Principles and Reconstruction. Taraxacum.

Shepard, Anna O.
1968 Ceramics for the Archaeologist (5th edition). Carnegie Institution of Washington, Publication 609. Washington, D.C.

APPENDIX 3

PROJECTILE POINT DATA

PLAINS SIDE NOTCHED

CATALOGUE NUMBER:	30146	30474	30665	31530	31533	38222	38573
AREA:	2	2	2	2	2	2	2
UNIT:	24	24	24	25	25	29	30
QUADRANT; SUBQUAD:	1,1	3,3	3,4	3,4	3,4	4,4	1,3
LEVEL:	1	1	1	1	1	1	1
SUBFILE; CLASS:	1,5	1,5	1,5	1,5	1,5	1,5	1,5
RAW MATERIAL:	1	8	4	1	5	6	8
SOURCE/VARIETY:	1						
WEIGHT:	.6	.3	.4	.6	.3	.4	.5
MAXIMUM LENGTH:	13.7	12.8	8.4	13.1	7.9	8.4	17.2
MAXIMUM WIDTH:	11.1	11.4	15.8	15.6	13.9	12.3	11.8
POS. MAX. WIDTH:		3.5		3.0			4.2
MAXIMUM THICKNESS:	3.5	2.3	3.3		3.0	3.0	2.8
POS. MAX. THICKNESS:		8.7					7.3
BLADE LENGTH:	5.0	6.3					11.0
STEM LENGTH:	8.7	6.5		8.3		8.4	6.5
BLADE WIDTH:		6.8					6.0
SHOULDER WIDTH:		9.8		13.6			5.9
POS. SHOULDER WIDTH:		6.6		8.6			6.6
NECK WIDTH:		7.8	7.9		9.3	8.1	7.3
POS. NECK:		5.4		6.9	6.0	6.6	5.3
STEM WIDTH:		11.4	15.8		13.9	12.3	
BASE WIDTH:		9.0	12.8		12.6	11.1	
BASAL NOTCH DEPTH:		.7					
NOTCH 1 DEPTH:		1.1					2.1
NOTCH 1 BREADTH:		3.3					2.4
NOTCH 2 DEPTH:	2.1	1.7		2.3			
NOTCH 2 BREADTH:	3.3	2.5		3.3			
PROX.-LAT. EDGE 1 HT.:		2.9	5.4		3.3	4.6	3.8
PROX.-LAT. EDGE 2 HT.:	3.4	4.4	6.4	6.0	3.1	5.0	
TIP ANGLE:							60
BLADE ANGLE:		55					
EDGE 1 ANGLE:		55					40
EDGE 2 ANGLE:		50					50
INTEGRITY:	8	2	4	9	4	4	5
LONG. X SEC.:		1					1
TRANS. X SEC.:	1	2					1
BLANK TYPE:							
BLANK ORIENTATION:							
FLAKING TYPE OBVERSE:		6					5
FLAKING PATTERN OBVERSE:		3					2
FLAKING TYPE REVERSE:		6					5
FLAKING PATTERN REVERSE:		3					3
BLADE EDGE 1 SHAPE:		1					1
BLADE EDGE 1 MORPHOLOGY:		2					5
BLADE EDGE 2 SHAPE:		1					1
BLADE EDGE 2 MORPHOLOGY:		2					2
SHOULDER 1 SHAPE:		3		3			1
SHOULDER 2 SHAPE:	4	3		4			1
EDGE GRINDING:		9		9		1	
BASE SHAPE:	1	3	1	3	1	1	3
BASAL THINNING:		3	3	3		3	3
NOTCH 1 SHAPE:		4				7	2
NOTCH 1 ORIENTATION:		1				2	1
NOTCH 2 SHAPE:	7	2		7		4	
NOTCH 2 ORIENTATION:	2	1		1		2	1
NOTCHING TECHNIQUE:		1	5	4	3	5	4
PROX.-LAT. EDGE 1:		3	3		1	1	3
PROX.-LAT. EDGE 2:	2	3	1	1	1	3	
TIP MORPHOLOGY:		5	5	7			1
WEAR TYPE:		1					
WEAR LOCATION:							
HEAT TREATMENT:							
FIGURE REFERENCE:	71.g	71.a	72.1	71.1	69.h	68.m	72.a

PLAINS SIDE NOTCHED

CATALOGUE NUMBER:	38584	38823	40564	40644	42671	42758	43327	47252
AREA:	2	2	2	2	2	2	2	12
UNIT:	30	30	31	31	33	33	34	
QUADRANT; SUBQUAD:	1,3	2,1	2,1	2,2	3,1	3,3	2,2	
LEVEL:	2	1	1	1	1	1	1	
SUBFILE; CLASS:	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5
RAW MATERIAL:	12	1	1	1	1	1	1	2
SOURCE/VARIETY:	2		3	1				
WEIGHT:	.8	1.0	1.4	.4	.3	.2	.6	.4
MAXIMUM LENGTH:	20.5	19.9	26.3	12.3	8.7	6.5	14.9	15.5
MAXIMUM WIDTH:	13.6	13.3	13.0	10.0	13.7	10.5	12.1	11.3
POS. MAX. WIDTH:	8.7	2.8	4.1					3.4
MAXIMUM THICKNESS:	2.6	4.1	5.0	3.2	3.2	2.9	3.5	2.8
POS. MAX. THICKNESS:	14.5	12.3	10.7					2.6
BLADE LENGTH:	13.6	11.6	18.6					9.3
STEM LENGTH:	6	8.3	7.7	6.5		6.5	9.2	6.2
BLADE WIDTH:	13.6	12.4	12.9					10.0
SHOULDER WIDTH:	13.0	12.3	11.9					9.6
POS. SHOULDER WIDTH:	8.5	8.2	8.0					6.0
NECK WIDTH:	8.3	8.5	8.5		8.6	6.3	7.7	7.0
POS. NECK:	5.5	5.9	6.6		5.9	5.2	7.6	4.8
STEM WIDTH:	13.0	13.3	8.0		13.7	10.5		11.3
BASE WIDTH:	12.7	11.0	6.5		10.9	8.9		9.0
BASAL NOTCH DEPTH:						.4		
NOTCH 1 DEPTH:	2.2	2.3	1.7					1.8
NOTCH 1 BREADTH:		4.4	3.4					2.4
NOTCH 2 DEPTH:	2.4	1.8	1.7	1.7			3.6	1.9
NOTCH 2 BREADTH:	3.9	4.7	3.6	2.9			4.1	2.5
PROX.-LAT. EDGE 1 HT.:	2.9	2.1	2.7		3.9	3.6		3.6
PROX.-LAT. EDGE 2 HT.:	2.1	2.4	4.4	3.5	3.9	3.9	4.6	2.7
TIP ANGLE:	90	65	55					85
BLADE ANGLE:								
EDGE 1 ANGLE:	50	60	40					30
EDGE 2 ANGLE:	45	45	55					30
INTEGRITY:	1	1	1	8	4	4	9	1
LONG. X SEC.:	3	5	3				1	3
TRANS. X SEC.:	4	1	3					4
BLANK TYPE:								
BLANK ORIENTATION:								
FLAKING TYPE OBVERSE:	6	5	7					5
FLAKING PATTERN OBVERSE:	1	8	4					3
FLAKING TYPE REVERSE:	5	5	5					5
FLAKING PATTERN REVERSE:	1	3	2					3
BLADE EDGE 1 SHAPE:	6	1	1					1
BLADE EDGE 1 MORPHOLOGY:	2	1	2					5
BLADE EDGE 2 SHAPE:	2	2	5					1
BLADE EDGE 2 MORPHOLOGY:	2	5	2					5
SHOULDER 1 SHAPE:		3	3					5
SHOULDER 2 SHAPE:	3	3	4	4			3	3
EDGE GRINDING:	2	1	1					
BASE SHAPE:	1	1	1		1	3	4	1
BASAL THINNING:	2	3	3		3	6		6
NOTCH 1 SHAPE:		7	7					1
NOTCH 1 ORIENTATION:	1	1	1		1	1	1	1
NOTCH 2 SHAPE:	4	4	5	8			2	7
NOTCH 2 ORIENTATION:	1	1	1	1	1	1	1	1
NOTCHING TECHNIQUE:	3	1	1		3	4	1	3
PROX.-LAT. EDGE 1:	1	8	8		1	3		1
PROX.-LAT. EDGE 2:	8	1	1	1	1	3	1	3
TIP MORPHOLOGY:	1	2	1					1
WEAR TYPE:								
WEAR LOCATION:								
HEAT TREATMENT:								
FIGURE REFERENCE:	67.p	67.n	67.m	71.h	68.n	72.g	70.d	67.e

SMALL NOTCHED

CATALOGUE NUMBER:	27662	27882	28070	28071	28743	28924	29250	29443	29445
AREA:	2	2	2	2	2	2	2	2	2
UNIT:	22	22	22	22	23	23	23	23	23
QUADRANT; SUBQUAD:	1,3	2,4	3,3	3,3	1,1	1,3	2,3	2,4	2,4
LEVEL:	1	1	1	1	1	1	1	1	1
SUBFILE; CLASS:	1,5	1,5	1,3	1,5	1,5	1,5	1,5	1,5	1,5
RAW MATERIAL:	8	2	1	4	1	2	7	2	1
SOURCE/VARIETY:						1			
WEIGHT:	.3	.3	.1	.2	.4	.6	.8	.2	1.0
MAXIMUM LENGTH:	7.2	16.1	6.9	5.9	15.5	11.6	18.0	6.5	18.3
MAXIMUM WIDTH:	10.8	9.2	9.8	10.9	12.5	12.5	13.5	10.2	12.9
POS. MAX. WIDTH:		6.5			4.8				9.4
MAXIMUM THICKNESS:	3.7	2.1	1.6	2.9	2.7	3.6	2.8	2.9	4.5
POS. MAX. THICKNESS:		3.0			3.9				5.9
BLADE LENGTH:		11.1			11.0				10.6
STEM LENGTH:		5.0			4.5	4.6			7.7
BLADE WIDTH:		9.2			12.5		13.4		12.9
SHOULDER WIDTH:		8.9			12.5		13.2		12.0
POS. SHOULDER WIDTH:		4.9			4.7				7.5
NECK WIDTH:	7.7	6.2			7.8	8.7	10.9	5.8	8.6
POS. NECK:	5.9	3.6			3.5	4.4		5.2	4.6
STEM WIDTH:	10.8	8.4		10.9	11.2	10.1		10.2	10.7
BASE WIDTH:	9.4	7.3		9.7	10.2			7.6	8.3
BASAL NOTCH DEPTH:		.5							
NOTCH 1 DEPTH:		.9			2.0	.5			1.5
NOTCH 1 BREADTH:		2.2			2.6	6.0			4.1
NOTCH 2 DEPTH:		1.3	1.5		2.1	1.3			1.3
NOTCH 2 BREADTH:		2.8	4.2		2.6	3.1	3.0		3.8
PROX.-LAT. EDGE 1 HT.:	3.3	2.3		2.0	2.0			5.3	
PROX.-LAT. EDGE 2 HT.:	2.7	1.3		2.7	1.2			2.7	
TIP ANGLE:		60			80		100		80
BLADE ANGLE:									
EDGE 1 ANGLE:		35			35		30		45
EDGE 2 ANGLE:		25			35		35		
INTEGRITY:	4	1	4	4	1	3	5	4	1
LONG. X SEC.:		1			1	1	1		9
TRANS. X SEC.:		2			1		2		9
BLANK TYPE:									
BLANK ORIENTATION:									
FLAKING TYPE OBVERSE:		5			5		5		5
FLAKING PATTERN OBVERSE:		4			8		3		1
FLAKING TYPE REVERSE:		5			5		5		5
FLAKING PATTERN REVERSE:		8			3		3		4
BLADE EDGE 1 SHAPE:		1			1		2		1
BLADE EDGE 1 MORPHOLOGY:		3			2		4		1
BLADE EDGE 2 SHAPE:		1			1		1		1
BLADE EDGE 2 MORPHOLOGY:		4			2		1		1
SHOULDER 1 SHAPE:		3			5				
SHOULDER 2 SHAPE:		4	3		3	3	3		1
EDGE GRINDING:		9							9
BASE SHAPE:	8	3		1	3	8		1	1
BASAL THINNING:	3	2	2	3	3			3	3
NOTCH 1 SHAPE:		5			7	8			
NOTCH 1 ORIENTATION:	1	1			3	8			1
NOTCH 2 SHAPE:		5	4		7	5	4		5
NOTCHING 2 ORIENTATION:	1	1	1		3	1	1	1	1
NOTCHING TECHNIQUE:	4	5		1	3	8	4	5	1
PROX.-LAT. EDGE 1:	3	8		2	7			3	3
PROX.-LAT. EDGE 2:	3		8	2	7	3		3	4
TIP MORPHOLOGY:	4	1			2	7	6	5	2
WEAR TYPE:					1				
WEAR LOCATION:					1				
HEAT TREATMENT:						4			
FIGURE REFERENCE:		68.c			67.f	68.t	68.v		67.q

SMALL NOTCHED

CATALOGUE NUMBER:	30004	30473	30394	31532	31534	32331	33786	34998	37050
AREA:	2	2	2	2	2	2	2	2	2
UNIT:	23	24	24	25	25	26	27	28	28
QUADRANT; SUBQUAD:	4,2	3,3	2,4	3,4	3,4	2,2	2,1	1,2	4,3
LEVEL:	1	1	1	1	1	1	1	1	1
SUBFILE; CLASS:	1,3	1,5	1,3	1,5	1,5	1,5	1,5	1,5	1,5
RAW MATERIAL:	6	1	1	1	2	12	1	1	1
SOURCE/VARIETY:			1	1		2			
WEIGHT:	.3	.3	.6	.3	.4	.5	.2	.4	.4
MAXIMUM LENGTH:	2.3	7.4	10.7	1.27	5.8	15.9	9.5	11.0	9.5
MAXIMUM WIDTH:	11.0	14.6	12.0	10.1	12.1	11.3	10.0	9.6	13.7
POS. MAX. WIDTH:	8.0			1.3		1.6	4.8	6.6	
MAXIMUM THICKNESS:	2.6	2.9	3.2	2.8	3.3	2.7	1.9	3.0	3.0
POS. MAX. THICKNESS:				4.6		5.2	3.6	6.6	
BLADE LENGTH:				7.4		10.0	5.5	5.5	
STEM LENGTH:	7.3		2.2	5.3		5.9	4.0	5.5	6.3
BLADE WIDTH:	11.0		12.0	8.3		8.5	9.9	4.6	
SHOULDER WIDTH:	10.6		11.7	8.0		8.5	9.3	4.5	
POS. SHOULDER WIDTH:	7.4		15.9	5.2		8.5	3.7	5.9	
NECK WIDTH:	5.6	9.1	9.8	5.6		8.1	6.9	6.5	9.8
POS. NECK:	4.7	5.6	4.3	3.4		6.5	3.1	3.7	4.9
STEM WIDTH:	9.9	14.6	10.4	10.1		11.3	9.6	4.1	13.3
BASE WIDTH:	8.3	11.2	10.0	9.5		10.3	8.5	7.4	12.1
BASAL NOTCH DEPTH:		1.2							
NOTCH 1 DEPTH:	2.5		1.4	.9	1.3	1.1	1.3	1.2	
NOTCH 1 BREADTH:	2.9		2.8	2.4	3.0	4.7	1.0	4.3	
NOTCH 2 DEPTH:	2.3			.3			1.6	1.6	2.0
NOTCH 2 BREADTH:	5.1			.9			1.3	3.0	4.0
PROX.-LAT. EDGE 1 HT.:	3.3	5.0			2.6	3.6	2.1		3.1
PROX.-LAT. EDGE 2 HT.:	2.4	3.2	1.8			3.5	2.0	2.7	
TIP ANGLE:						65	110	85	
BLADE ANGLE:				30					
EDGE 1 ANGLE:	40			35		55	25	50	
EDGE 2 ANGLE:	45			40		55	25	70	
INTEGRITY:	2	4	2	2	4	1	1	1	4
LONG. X SEC.:	8		3	1		4	1	3	
TRANS. X SEC.:				2		4	2	1	
BLANK TYPE:						4			
BLANK ORIENTATION:						1			
FLAKING TYPE OBVERSE:			8	8		8	8	8	
FLAKING PATTERN OBVERSE:			8	8		1	8	3	
FLAKING TYPE REVERSE:			8	8		5	8	8	
FLAKING PATTERN REVERSE:			8	8		3	8	3	
BLADE EDGE 1 SHAPE:				5		1	2	1	
BLADE EDGE 1 MORPHOLOGY:				1		6	1	1	
BLADE EDGE 2 SHAPE:			5	1		1	2	1	
BLADE EDGE 2 MORPHOLOGY:				1		6	1	1	
SHOULDER 1 SHAPE:	6		2	4	4	3	6	3	
SHOULDER 2 SHAPE:	3					9	6	5	
EDGE GRINDING:	3		1			5		2	
BASE SHAPE:	1	8	1	1		1	1	1	1
BASAL THINNING:	1	3	3	1	6	1	2	3	
NOTCH 1 SHAPE:	8		4	4	5	7	2	6	
NOTCH 1 ORIENTATION:	1		1	1	1	1	1	1	
NOTCH 2 SHAPE:	4						2	4	
NOTCH 2 ORIENTATION:	1						1	1	1
NOTCHING TECHNIQUE:	5	4		4		7	3	5	
PROX.-LAT. EDGE 1:	1	3	1	5	1	4	3		1
PROX.-LAT. EDGE 2:	3	3		4			3	1	
TIP MORPHOLOGY:	6			5		1	1	1	
WEAR TYPE:									
WEAR LOCATION:									
HEAT TREATMENT:									1
FIGURE REFERENCE:	68.r	72.h	72.m	71.e	72.d	67.c	68.g	71.f	

SMALL NOTCHED

CATALOGUE NUMBER:	37055	37581	37833	38120	38578	38821	38822	38830	39209
AREA:	2	2	2	2	2	2	2	2	2
UNIT:	28	29	29	29	30	30	30	30	30
QUADRANT; SUBQUAD:	4,4	2,3	3,3	4,3	1,3	2,1	2,1	2,2	3,1
LEVEL:	1	1	1	1	1	1	1	1	2
SUBFILE; CLASS:	1,5	1,5	1,5	1,5	1,5	1,3	1,5	1,5	1,5
RAW MATERIAL:	8	1	1	1	2	16	1	5	6
SOURCE/VARIETY:				1	1				
WEIGHT:	.4	.5	.6	.3	.4	.3	.7	.6	.5
MAXIMUM LENGTH:	14.7	13.0	12.4	10.7	11.8	11.9	15.6	17.3	13.7
MAXIMUM WIDTH:	10.5	14.3	14.7	9.0	10.6	12.9	10.5	9.6	9.9
POS. MAX. WIDTH:	5.8	2.6	3.1	6.9	6.3		2.8	7.9	9.3
MAXIMUM THICKNESS:	3.1	3.3	3.3	3.0	2.9	2.1	5.0	3.6	3.9
POS. MAX. THICKNESS:	2.2	8.9		4.1	5.7	2.9	8.1	9.5	7.8
BLADE LENGTH:	9.2	4.9			7.3			10.4	
STEM LENGTH:	5.5	8.1	7.2	6.1	4.5	5.5	6.5	6.9	7.0
BLADE WIDTH:	10.5	8.4		9.0	10.6		10.2	9.6	9.9
SHOULDER WIDTH:	10.3	8.3		8.8	10.5		10.2	9.3	9.7
POS. SHOULDER WIDTH:	5.1	8.0		6.5	6.1		6.4	6.9	7.3
NECK WIDTH:	6.7	8.1	9.0	6.2	7.3	9.0	8.7		6.0
POS. NECK:	3.9	6.9	6.2	3.3	4.1	4.4	5.0	5.2	4.9
STEM WIDTH:		14.3	14.7	8.7		12.9	10.6		9.4
BASE WIDTH:		10.7	12.0	6.5		11.1	6.7		8.4
BASAL NOTCH DEPTH:									
NOTCH 1 DEPTH:	1.8	.9		1.3	1.7	2.3	1.0	1.5	1.6
NOTCH 1 BREADTH:	3.4	5.3		5.3	3.5	3.2	3.1	3.5	3.7
NOTCH 2 DEPTH:		1.2		.9			.9		1.9
NOTCH 2 BREADTH:		3.1	4.4	4.2		3.6	3.3		4.3
PROX.-LAT. EDGE 1 HT.:			3.9	1.0	2.7			2.6	2.9
PROX.-LAT. EDGE 2 HT.:		4.8		1.5					1.8
TIP ANGLE:		105						80	
BLADE ANGLE:	35								
EDGE 1 ANGLE:	35	50			35		70	60	40
EDGE 2 ANGLE:	40						60		40
INTEGRITY:	9	1	3	2	9	3	2	5	2
LONG. X SEC.:	1	5	1	5	1	4	7	8	1
TRANS. X SEC.:	8	3	1	3	1		3	1	1
BLANK TYPE:						4			
BLANK ORIENTATION:						6			
FLAKING TYPE OBVERSE:	5	8			5	6	5	8	5
FLAKING PATTERN OBVERSE:	3	1			8		1	8	2
FLAKING TYPE REVERSE:	5	8			5		5	8	5
FLAKING PATTERN REVERSE:	2	1					1	8	2
BLADE EDGE 1 SHAPE:	1	1					9	9	
BLADE EDGE 1 MORPHOLOGY:	2	6					2	8	1
BLADE EDGE 2 SHAPE:	1	1					1	2	
BLADE EDGE 2 MORPHOLOGY:	5	6					5	2	1
SHOULDER 1 SHAPE:	3	3		3	3	1	3	4	3
SHOULDER 2 SHAPE:	3	3		3			4		3
EDGE GRINDING:			2					1	2
BASE SHAPE:		3	1	1	1	1	1	3	1
BASAL THINNING:		3	3	3		1	1	3	3
NOTCH 1 SHAPE:	7	6		6	7	7	4	4	4
NOTCH 1 ORIENTATION:	1	1	1	1	1	1	1	1	1
NOTCH 2 SHAPE:		4	7	5			4		4
NOTCH 2 ORIENTATION:	1	1	1	1		1	1		1
NOTCHING TECHNIQUE:	2	2	5	1		1	5		3
PROX.-LAT. EDGE 1:	8		1	4	1	5	4	4	1
PROX.-LAT. EDGE 2:		2		8		5			8
TIP MORPHOLOGY:	7	1	9	7	6	7	7	3	5
WEAR TYPE:		2	2						
WEAR LOCATION:		2	2						
HEAT TREATMENT:									
FIGURE REFERENCE:	68.p	67.a	67.b	72.b	68.q	72.1	70.e	68.u	68.s

SMALL NOTCHED

CATALOGUE NUMBER:	39782	40449	40450	40451	40640	30641	40800	40888	41156
AREA:	2	2	2	2	2	2	2	2	2
UNIT:	30	31	31	31	31	31	31	31	31
QUADRANT; SUBQUAD:	4,1	1,4	1,4	1,4	-2,2	2,2	3,2	3,3	4,1
LEVEL:	1	1	1	1	1	1	1	1	1
SUBFILE; CLASS:	1,3	1,5	1,5	1,5	1,3	1,5	1,5	1,3	1,3
RAW MATERIAL:	1	4	1	1	1	4	1	5	6
SOURCE/VARIETY:									
WEIGHT:	.5	.5	.4	.2	.2	.1	.2	.2	.4
MAXIMUM LENGTH:	17.4	9.8	11.3	5.2	11.6	5.4	10.6	9.6	9.8
MAXIMUM WIDTH:	10.3	12.9	12.1	6.1	9.8	9.0	10.2	11.4	11.5
POS. MAX. WIDTH:	6.5	3.2					1.8		
MAXIMUM THICKNESS:	2.9	3.4	3.0	3.4	1.9	2.4	2.3	2.0	2.6
POS. MAX. THICKNESS:	7.5				2.0		3.2		
BLADE LENGTH:	9.8						4.6		
STEM LENGTH:	7.5	8.5	7.0		5.7		6.0		6.9
BLADE WIDTH:	9.8						8.5		
SHOULDER WIDTH:	9.8						8.3		
POS. SHOULDER WIDTH:	7.5						6.2		
NECK WIDTH:	7.1	10.0	8.7		6.8		5.6		8.7
POS. NECK:	4.4	5.8	5.9		3.9		3.6		5.4
STEM WIDTH:	8.3	12.9	12.1		9.8	9.0	10.1		6.5
BASE WIDTH:	7.8	10.8	11.1		8.7	7.3	9.6		9.7
BASAL NOTCH DEPTH:									
NOTCH 1 DEPTH:		.5	1.9				1.9	2.0	.8
NOTCH 1 BREADTH:		4.3	4.0				4.8	3.0	2.0
NOTCH 2 DEPTH:	1.8	.9			1.6		1.8		1.2
NOTCH 2 BREADTH:	3.7	4.9			2.9		3.7		4.2
PROX.-LAT. EDGE 1 HT.:		3.8	2.5		1.9	1.9	.9	3.3	2.3
PROX.-LAT. EDGE 2 HT.:		3.5	1.7		1.4	3.6	2.2		2.7
TIP ANGLE:	60						85		
BLADE ANGLE:									
EDGE 1 ANGLE:	50						40		
EDGE 2 ANGLE:	40						40		
INTEGRITY:	1	4	3	4	3	4	1	4	3
LONG. X SEC.:	8	2			2		1		2
TRANS. X SEC.:	1				2		1		
BLANK TYPE:	5				2				
BLANK ORIENTATION:					1				
FLAKING TYPE OBVERSE:	5				6		5		
FLAKING PATTERN OBVERSE:	4				1		3		
FLAKING TYPE REVERSE:	5				9		5		
FLAKING PATTERN REVERSE:	2				9		3		
BLADE EDGE 1 SHAPE:	2				2		1		
BLADE EDGE 1 MORPHOLOGY:	2						2		
BLADE EDGE 2 SHAPE:	1				1		1		
BLADE EDGE 2 MORPHOLOGY:	2				4		2		
SHOULDER 1 SHAPE:			6				3	3	4
SHOULDER 2 SHAPE:	3				3		3		4
EDGE GRINDING:	9	6			9		9		2
BASE SHAPE:	1	1	2	1	1	1	1		1
BASAL THINNING:	1	3	3		3		3		1
NOTCH 1 SHAPE:		6	4				4	7	4
NOTCH 1 ORIENTATION:		1	1				1	1	1
NOTCH 2 SHAPE:	4	4			7		7		4
NOTCH 2 ORIENTATION:	1	1	1		1		1		1
NOTCHING TECHNIQUE:	7	1					4		1
PROX.-LAT. EDGE 1:		3	1		4	3	4		3
PROX.-LAT. EDGE 2:	4	3	6	6	8	1	8		3
TIP MORPHOLOGY:	2	6	7		2		2		5
WEAR TYPE:									
WEAR LOCATION:									
HEAT TREATMENT:									
FIGURE REFERENCE:	68.d	69.i	68.1		68.k		71.d		68.i

SMALL NOTCHED

CATALOGUE NUMBER:	41293	42132	42244	42419	42523	42794	43165	43540	43745
AREA:	2	2	2	2	2	2	2	2	2
UNIT:	31	32	32	33	33	33	34	34	34
QUADRANT; SUBQUAD:	4,3	3,3	4,1	1,1	2,1	3,4	1,3	3,3	4,4
LEVEL:	2	1	1	1	1	1	1	1	1
SUBFILE; CLASS:	1,5	1,5	1,5	1,5	1,3	1,5	1,5	1,5	1,5
RAW MATERIAL:	1	1	2	1	3	3	2	4	6
SOURCE/VARIETY:	3	3	1						
WEIGHT:	.1	.9	.1	.5	.4	.6	1.1	.3	.8
MAXIMUM LENGTH:	6.4	17.6	12.7	12.5	11.4	18.1	22.9	9.9	16.4
MAXIMUM WIDTH:	11.7	13.0	5.5	13.5	11.3	10.2	14.0	11.8	13.4
POS. MAX. WIDTH:		8.8		3.3	2.7	7.3	9.1		
MAXIMUM THICKNESS:	2.2	3.7	2.6	3.6	2.7	3.5	3.9	3.3	3.6
POS. MAX. THICKNESS:		9.2		8.0	5.6	7.1	8.2		9.3
BLADE LENGTH:				6.6	5.9	11.4	16.4		
STEM LENGTH:		7.9		5.9	5.4	6.7	6.6		7.6
BLADE WIDTH:		13.0		9.9	10.8	10.2	14.0		13.3
SHOULDER WIDTH:		12.8		9.8	10.8	9.9	13.1		13.2
POS. SHOULDER WIDTH:		7.9		6.5	5.4	7.2	7.2		8.0
NECK WIDTH:	6.2	7.8		8.4	9.5	7.2	7.3	6.2	9.5
POS. NECK:	5.9	4.4		5.5	4.2	5.6	5.5	5.4	5.9
STEM WIDTH:	11.7	9.6	5.5	13.5	11.4	9.2		11.8	
BASE WIDTH:	9.7	8.9	11.0	11.2	9.8	6.3		8.1	
BASAL NOTCH DEPTH:			.5		1.1	.8			
NOTCH 1 DEPTH:		2.2		1.5	.8	1.1			
NOTCH 1 BREADTH:		6.2		4.4	2.4	2.8			3.7
NOTCH 2 DEPTH:		1.6		1.5	.5	1.1			2.0
NOTCH 2 BREADTH:		5.8		4.2	2.1	4.2			4.8
PROX.-LAT. EDGE 1 HT.:		1.9		1.5	2.9			4.5	
PROX.-LAT. EDGE 2 HT.:	4.5	1.0			2.4			2.4	2.4
TIP ANGLE:				105	110	65			
BLADE ANGLE:									
EDGE 1 ANGLE:		55		70	55	50	40		40
EDGE 2 ANGLE:		40		60	60	45	40		45
INTEGRITY:	4	9	4	1	1	1	9	4	9
LONG. X SEC.:		5		5	1	1	1		3
TRANS. X SEC.:		4		1	1	1	1		3
BLANK TYPE:									
BLANK ORIENTATION:									
FLAKING TYPE OBVERSE:		7		7	8	8	5		8
FLAKING PATTERN OBVERSE:		4		4	8	8	8		1
FLAKING TYPE REVERSE:		7		5	8	8	5		8
FLAKING PATTERN REVERSE:		4		4	8	8	8		1
BLADE EDGE 1 SHAPE:				2	5	2	2		
BLADE EDGE 1 MORPHOLOGY:		2		2	4	5	2		2
BLADE EDGE 2 SHAPE:				5	2	1	5		
BLADE EDGE 2 MORPHOLOGY:		1		2	1	5	2		2
SHOULDER 1 SHAPE:		3		3	3	4	4		3
SHOULDER 2 SHAPE:		4		4	3	4	3		3
EDGE GRINDING:				2	1	6	9	2	7
BASE SHAPE:	8		3	1	3	3	1	1	3
BASAL THINNING:				3	1	3		3	3
NOTCH 1 SHAPE:		8		4	4				
NOTCH 1 ORIENTATION:	1	1		3	1	1	1	1	1
NOTCH 2 SHAPE:		6		4	7	4	7		5
NOTCH 2 ORIENTATION:	1	1		1	1	1	1	1	1
NOTCHING TECHNIQUE:	1	4		1	4	5	3	4	5
PROX.-LAT. EDGE 1:	3		7	4	1			8	
PROX.-LAT. EDGE 2:	3		2		3	4		8	7
TIP MORPHOLOGY:		5		1	2	1	5		6
WEAR TYPE:									
WEAR LOCATION:									
HEAT TREATMENT:			1						
FIGURE REFERENCE:	72.f	70.f		71.k	71.e	67.j	72.k		67.h

SMALL NOTCHED

CATALOGUE NUMBER:	43797	43995	44183	44273	44275	44493	44862	45836	45890
AREA:	2	2	2	2	2	2	2	2	2
UNIT:	35	35	35	35	35	36	36	38	38
QUADRANT; SUBQUAD:	1,1	1,3	2,2	2,4	2,4	1,2	2,2	2,1	2,2
LEVEL:	1	1	1	1	1	1	1	1	1
SUBFILE; CLASS:	1,3	1,5	1,3	1,5	1,5	1,5	1,5	1,5	1,5
RAW MATERIAL:	4	5	12	2	1	1	5	2	3
SOURCE/VARIETY:			2	1	3	3			
WEIGHT:	.7	.2	.3	.7	.2	.3	.2	.3	.9
MAXIMUM LENGTH:	9.1	7.6	15.1	18.0	9.4	7.4	5.5	14.6	19.7
MAXIMUM WIDTH:	9.4	12.1	9.5	12.4	9.4	13.5	13.3	9.2	12.6
POS. MAX. WIDTH:	2.2		7.4	7.9				2.3	6.7
MAXIMUM THICKNESS:	2.3	2.6	2.5	3.3	2.6	2.5	2.6	2.6	4.0
POS. MAX. THICKNESS:			3.2	6.4				7.0	6.9
BLADE LENGTH:			9.5	11.0				8.3	13.7
STEM LENGTH:	5.8	7.4	5.6	7.0	6.0	7.2		6.3	6.0
BLADE WIDTH:	9.0		9.5	12.4				9.0	12.6
SHOULDER WIDTH:	8.9		9.3	12.0				8.9	12.5
POS. SHOULDER WIDTH:	5.9		5.9	6.9				6.7	6.4
NECK WIDTH:	7.3	9.0	8.0	8.3		9.8	3.7	7.1	8.9
POS. NECK:	4.2	4.8	4.3	4.5		6.6	5.5	5.2	4.1
STEM WIDTH:	9.4	12.1	9.0	11.3		13.5	13.3	9.2	
BASE WIDTH:	7.6	10.0	8.2	8.7		10.4	6.9	6.7	
BASAL NOTCH DEPTH:		.9							
NOTCH 1 DEPTH:	.9		1.1	1.7				1.0	
NOTCH 1 BREADTH:	3.3		2.3	4.9				3.7	
NOTCH 2 DEPTH:	.9		1.1	1.7	1.7			.9	1.8
NOTCH 2 BREADTH:	2.8		1.6	3.8	3.8			3.0	4.2
PROX.-LAT. EDGE 1 HT.:	1.2	2.6	2.7			3.8	2.6		
PROX.-LAT. EDGE 2 HT.:	2.4	3.2	3.0		1.7	3.7	3.3		1.7
TIP ANGLE:			90	80				75	95
BLADE ANGLE:								60	
EDGE 1 ANGLE:			35	40				50	50
EDGE 2 ANGLE:			25	45				60	40
INTEGRITY:	3	4	1	1	4	4	4	1	5
LONG. X SEC.:	5		1	1				1	1
TRANS. X SEC.:			4	1				1	1
BLANK TYPE:	2		2						
BLANK ORIENTATION:	2		1						
FLAKING TYPE OBVERSE:			6	7				8	8
FLAKING PATTERN OBVERSE:			8	3				8	8
FLAKING TYPE REVERSE:	6		6	7				8	8
FLAKING PATTERN REVERSE:	8		8	3				8	8
BLADE EDGE 1 SHAPE:			2	1				1	6
BLADE EDGE 1 MORPHOLOGY:			2	2				5	2
BLADE EDGE 2 SHAPE:			2	5				1	2
BLADE EDGE 2 MORPHOLOGY:			2	2				1	2
SHOULDER 1 SHAPE:	4		4					4	3
SHOULDER 2 SHAPE:	3		4	4	3			4	4
EDGE GRINDING:	7		9	1			1	9	
BASE SHAPE:	1	3	1	1		1	1	1	1
BASAL THINNING:	1	2	2	2		3	3	2	3
NOTCH 1 SHAPE:	4		4	4				6	
NOTCH 1 ORIENTATION:	1	1	1	1		1	1	1	1
NOTCH 2 SHAPE:	4		7	4	7			4	4
NOTCH 2 ORIENTATION:	1	1	1	1	1	1	1	1	1
NOTCHING TECHNIQUE:	3	4	5	5		3	1	4	4
PROX.-LAT. EDGE 1:	1	3	3	4		8	1	3	
PROX.-LAT. EDGE 2:	1	3	1	4	8	8	1	4	7
TIP MORPHOLOGY:	5		1	1				1	3
WEAR TYPE:									
WEAR LOCATION:									
HEAT TREATMENT:				2		3			
FIGURE REFERENCE:	68.j	68.o	67.d	67.k		72.j		68.b	67.o

SMALL NOTCHED

CATALOGUE NUMBER:	45949	46128	46250	47215	47314
AREA:	2	12	12	2	2
UNIT:	38	6	999	26	31
QUADRANT; SUBQUAD:	2,3	4			
LEVEL:	1	2		1	
SUBFILE; CLASS:	1,5	1,5	1,5	1,3	1,5
RAW MATERIAL:	6	1	4	6	5
SOURCE/VARIETY:					
WEIGHT:	1.1	.6	.3	.1	.3
MAXIMUM LENGTH:	19.3	15.4	12.1	11.3	11.9
MAXIMUM WIDTH:	14.5	12.4	10.0	7.6	10.0
POS. MAX. WIDTH:	7.9	7.7	6.0	2.5	4.5
MAXIMUM THICKNESS:	3.8	2.9	2.8	1.7	2.4
POS. MAX. THICKNESS:	5.4	4.6	5.2	1.9	5.8
BLADE LENGTH:	11.9	8.3		5.5	
STEM LENGTH:	7.4	7.2	6.0	5.8	4.1
BLADE WIDTH:	14.5	12.4	10.1	6.5	10.0
SHOULDER WIDTH:	14.3	12.4	9.9	6.4	10.0
POS. SHOULDER WIDTH:	7.8	7.4	5.7	5.9	4.1
NECK WIDTH:	9.7	7.9	5.9	5.6	6.2
POS. NECK:	5.3	5.6	4.5	4.4	2.8
STEM WIDTH:	11.4	11.7	9.8	7.6	8.1
BASE WIDTH:	10.7	11.2	9.4	6.5	7.8
BASAL NOTCH DEPTH:					
NOTCH 1 DEPTH:	2.0	2.4	2.2	.6	1.1
NOTCH 1 BREADTH:	4.1	5.2	3.2	3.2	2.7
NOTCH 2 DEPTH:	1.9	1.7	2.1	.6	1.5
NOTCH 2 BREADTH:	3.3	4.4	3.3	2.6	3.1
PROX.-LAT. EDGE 1 HT.:		1.0	2.0		
PROX.-LAT. EDGE 2 HT.:		1.1			
TIP ANGLE:	80	85	80	75	
BLADE ANGLE:					
EDGE 1 ANGLE:	60	40	60	30	
EDGE 2 ANGLE:	45	50		30	45
INTEGRITY:	5	1	2	1	3
LONG. X SEC.:	3	1	3	2	1
TRANS. X SEC.:	3	1	4	2	1
BLANK TYPE:				2	
BLANK ORIENTATION:				2	
FLAKING TYPE OBVERSE:	8	5	5	1	5
FLAKING PATTERN OBVERSE:	8	3	8	3	8
FLAKING TYPE REVERSE:	8	5	5	1	5
FLAKING PATTERN REVERSE:	8	3	8	3	8
BLADE EDGE 1 SHAPE:	1	1		1	
BLADE EDGE 1 MORPHOLOGY:	9	1	5	1	
BLADE EDGE 2 SHAPE:	2	5		2	1
BLADE EDGE 2 MORPHOLOGY:	9	2		1	2
SHOULDER 1 SHAPE:	4	3	3	4	3
SHOULDER 2 SHAPE:	1	3	3	4	5
EDGE GRINDING:	9	2	2		2
BASE SHAPE:	2	2	2	2	1
BASAL THINNING:	3	3	2	2	3
NOTCH 1 SHAPE:	5	4	7	6	4
NOTCH 1 ORIENTATION:	1	1	1	1	3
NOTCH 2 SHAPE:		4	7	6	7
NOTCH 2 ORIENTATION:	1	1	3	1	3
NOTCHING TECHNIQUE:		3	3	4	5
PROX.-LAT. EDGE 1:	8	4	4	6	4
PROX.-LAT. EDGE 2:		4	4	6	5
TIP MORPHOLOGY:	2	1	5	1	5
WEAR TYPE:					
WEAR LOCATION:					
HEAT TREATMENT:					
FIGURE REFERENCE:	67.r	67.1	68.e	68.h	68.a

	AVONLEA TYPE 1				AVONLEA TYPE 2
CATALOGUE NUMBER:	46247	29122	45948	32685	29907
AREA:	12	2	2	2	2
UNIT:		23	38	26	2.3
QUADRANT; SUBQUAD:		1,4	2,3	3,2	4,1
LEVEL:		2	1	1	1
SUBFILE; CLASS:	1,5	1,5	1,3	1,5	1,5
RAW MATERIAL:	1	1	1	1	7
SOURCE/VARIETY:					
WEIGHT:	.5	.4	.4	.5	.7
MAXIMUM LENGTH:	12.5	10.8	15.5	15.8	14.4
MAXIMUM WIDTH:	13.1	13.7	10.4	11.8	14.2
POS. MAX. WIDTH:				5.5	7.0
MAXIMUM THICKNESS:	2.6	2.6	2.0	2.7	3.7
POS. MAX. THICKNESS:				4.1	8.4
BLADE LENGTH:				11.2	
STEM LENGTH:		5.2		4.6	5.7
BLADE WIDTH:	12.3	13.7	10.4	11.7	14.2
SHOULDER WIDTH:	12.3	13.7	10.3	11.7	13.6
POS. SHOULDER WIDTH:	5.3	5.4		4.8	5.5
NECK WIDTH:	11.0	11.3		10.8	8.2
POS. NECK:	4.1	3.6		4.1	4.7
STEM WIDTH:				11.4	12.5
BASE WIDTH:				9.2	10.0
BASAL NOTCH DEPTH:				1.0	.4
NOTCH 1 DEPTH:			.8	.9	2.2
NOTCH 1 BREADTH:		2.1	1.7	3.0	3.2
NOTCH 2 DEPTH:	.8	1.4		.8	2.7
NOTCH 2 BREADTH:	2.4	2.4		2.4	4.0
PROX.-LAT. EDGE 1 HT.:				1.5	2.9
PROX.-LAT. EDGE 2 HT.:	2.9	2.7		2.8	1.6
TIP ANGLE:				70	
BLADE ANGLE:					
EDGE 1 ANGLE:	30		25	30	45
EDGE 2 ANGLE:	30		20	35	45
INTEGRITY:	9	6	9	1	3
LONG. X SEC.:	5	1	2	1	5
TRANS. X SEC.:			2	4	
BLANK TYPE:					
BLANK ORIENTATION:					
FLAKING TYPE OBVERSE:	5		6	5	
FLAKING PATTERN OBVERSE:	8		8	3	
FLAKING TYPE REVERSE:	1		7	5	
FLAKING PATTERN REVERSE:	4		1	3	
BLADE EDGE 1 SHAPE:	1		2	2	
BLADE EDGE 1 MORPHOLOGY:	2		1	5	
BLADE EDGE 2 SHAPE:	1		2	2	
BLADE EDGE 2 MORPHOLOGY:	2		1	5	
SHOULDER 1 SHAPE:	3	3	3	3	4
SHOULDER 2 SHAPE:	3	3	3	3	2
EDGE GRINDING:	5	2		9	3
BASE SHAPE:	3	3		3	3
BASAL THINNING:	3	3		3	3
NOTCH 1 SHAPE:			7	6	4
NOTCH 1 ORIENTATION:		1	1	1	3
NOTCH 2 SHAPE:	4	7		5	7
NOTCH 2 ORIENTATION:	1	1		1	3
NOTCHING TECHNIQUE:	1	4		4	4
PROX.-LAT. EDGE 1:				4	3
PROX.-LAT. EDGE 2:	1	3		4	4
TIP MORPHOLOGY:	7	5	5	2	8
WEAR TYPE:					
WEAR LOCATION:					
HEAT TREATMENT:			2		
FIGURE REFERENCE:	71.i	71.j	72.c	67.1	67.g

TRIANGULAR

CATALOGUE NUMBER:	27783	27816	29521	29827	29908	33435	34320	36979	37054
AREA:	2	2	2	2	2	2	2	2	2
UNIT:	22	22	23	23	23	27	27	28	28
QUADRANT; SUBQUAD:	2,2	2,3	3,2	3,4	4,1	1,2	3,3	4,2	4,4
LEVEL:	1	1	1	1	1	1	1	1	1
SUBFILE; CLASS:	1,5	1,5	1,3	1,5	1,5	1,5	1,3	1,5	1,5
RAW MATERIAL:	5	1	6	1	1	2	3	1	1
SOURCE/VARIETY:		1							
WEIGHT:	.7	1.0	.7	.3	.4	.9	1.0	.5	.2
MAXIMUM LENGTH:	15.6	17.5	18.1	8.0	11.9	17.4	18.5	14.9	7.6
MAXIMUM WIDTH:	13.4	16.0	13.1	14.5	12.3	13.9	13.5	9.4	10.2
POS. MAX. WIDTH:	3.5		1.8	5.0	7.7	2.2	6.8	5.7	
MAXIMUM THICKNESS:	3.4	4.4	2.8		2.1	3.2	3.9	3.3	2.3
POS. MAX. THICKNESS:	5.1		11.0	2.7	5.9	8.9	11.8	8.7	
BLADE LENGTH:									
STEM LENGTH:									
BLADE WIDTH:									
SHOULDER WIDTH:									
POS. SHOULDER WIDTH:									
NECK WIDTH:									
POS. NECK:									
STEM WIDTH:									
BASE WIDTH:									6.7
BASAL NOTCH DEPTH:									
NOTCH 1 DEPTH:									
NOTCH 1 BREADTH:									
NOTCH 2 DEPTH:									
NOTCH 2 BREADTH:									
PROX.-LAT. EDGE 1 HT.:									
PROX.-LAT. EDGE 2 HT.:									
TIP ANGLE:							70		
BLADE ANGLE:			35						
EDGE 1 ANGLE:	45	40	30			35	45	55	
EDGE 2 ANGLE:	45	50	60			35	55	45	
INTEGRITY:	2	9	1	4	4	2	1	2	4
LONG. X SEC.:	3	5	4		4	1	4	8	
TRANS. X SEC.:	1		3		2	1	4	3	
BLANK TYPE:	4		5						
BLANK ORIENTATION:	6								
FLAKING TYPE OBVERSE:	5	8	5		6	5	5	5	
FLAKING PATTERN OBVERSE:	2	8	4		1	4	8	1	
FLAKING TYPE REVERSE:	5	8	5		8	5	8	5	
FLAKING PATTERN REVERSE:	2	8	2		1	3	1	1	
BLADE EDGE 1 SHAPE:	2	5	1			5	2	1	
BLADE EDGE 1 MORPHOLOGY:	5	1	2		2	2	6	1	
BLADE EDGE 2 SHAPE:	5		5			1	2	2	
BLADE EDGE 2 MORPHOLOGY:	2		2			2	6	1	
SHOULDER 1 SHAPE:						9		9	
SHOULDER 2 SHAPE:						9		9	
EDGE GRINDING:						9		9	
BASE SHAPE:	1	1	1	1	3	3	1	1	1
BASAL THINNING:			2		2	7	2		
NOTCH 1 SHAPE:						9		9	
NOTCH 1 ORIENTATION:						9		9	
NOTCH 2 SHAPE:						9		9	
NOTCH 2 ORIENTATION:						9		9	
NOTCHING TECHNIQUE:						9		9	
PROX.-LAT. EDGE 1:						7			
PROX.-LAT. EDGE 2:									
TIP MORPHOLOGY:	2	7	2	5	7	7	2	5	7
WEAR TYPE:		1							
WEAR LOCATION:		2							
HEAT TREATMENT:									
FIGURE REFERENCE:	69.f	71.p	69.e		71.o	71.m	69.c		

TRIANGULAR

CATALOGUE NUMBER:	37764	37765	38574	38829	40014	42245	43595	46169	46258
AREA:	2	2	2	2	2	2	2	12	12
UNIT:	29	29	30	30	30	32	34	8	
QUADRANT; SUBQUAD:	3,1	3,1	1,3	2,2	4,1	4,1	3,4	1	
LEVEL:	1	1	1	1	1	2	1	1	
SUBFILE; CLASS:	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5
RAW MATERIAL:	1	1	12	1	3	7	1	1	12
SOURCE/VARIETY:	3		2					1	2
WEIGHT:	.5	.7	.9	2.5	1.3	.6	1.0	.9	.4
MAXIMUM LENGTH:	14.1	17.8	15.8	24.0	19.3	17.2	14.1	15.4	12.3
MAXIMUM WIDTH:	11.0		13.7	19.3	14.9	12.5	16.4	16.7	12.3
POS. MAX. WIDTH:	2.0		6.0		3.2	9.5	5.8		
MAXIMUM THICKNESS:	2.9	4.1	4.0	5.9	4.3	2.3	4.5	3.5	2.4
POS. MAX. THICKNESS:	4.3	4.9	12.4		7.3	5.5			
BLADE LENGTH:									
STEM LENGTH:									
BLADE WIDTH:									
SHOULDER WIDTH:									
POS. SHOULDER WIDTH:									
NECK WIDTH:									
POS. NECK:									
STEM WIDTH:									
BASE WIDTH:								14.9	
BASAL NOTCH DEPTH:		6							
NOTCH 1 DEPTH:									
NOTCH 1 BREADTH:									
NOTCH 2 DEPTH:									
NOTCH 2 BREADTH:									
PROX.-LAT. EDGE 1 HT.:									
PROX.-LAT. EDGE 2 HT.:									
TIP ANGLE:	80	45							
BLADE ANGLE:					30				
EDGE 1 ANGLE:	45	55	40		50	25			
EDGE 2 ANGLE:	30	50	30		45	25			
INTEGRITY:	1	5	2	9	2	2	4	4	4
LONG. X SEC.:	4	4	2	8	1	6	3	2	
TRANS. X SEC.:	4	3	1	3	1	2			
BLANK TYPE:						5			
BLANK ORIENTATION:									
FLAKING TYPE OBVERSE:	6	5	8	8	8	6			
FLAKING PATTERN OBVERSE:	8	3	2	8	8	1			
FLAKING TYPE REVERSE:	8	5	8	8	8	8			
FLAKING PATTERN REVERSE:	8	2	1	2	8	8			
BLADE EDGE 1 SHAPE:	6	2	5	2	1	2			
BLADE EDGE 1 MORPHOLOGY:	9	2	2	1	1	1			
BLADE EDGE 2 SHAPE:	2	5	5		2	2			
BLADE EDGE 2 MORPHOLOGY:	5	2	2		1	1			
SHOULDER 1 SHAPE:									
SHOULDER 2 SHAPE:									
EDGE GRINDING:					9			1	1
BASE SHAPE:	1		8		3	1	1	1	1
BASAL THINNING:	3		1		3	3		3	3
NOTCH 1 SHAPE:									
NOTCH 1 ORIENTATION:									
NOTCH 2 SHAPE:									
NOTCH 2 ORIENTATION:									
NOTCHING TECHNIQUE:									
PROX.-LAT. EDGE 1:									
PROX.-LAT. EDGE 2:									
TIP MORPHOLOGY:	1	2	7	5	7	7	7		4
WEAR TYPE:									
WEAR LOCATION:									
HEAT TREATMENT:		7							
FIGURE REFERENCE:	69.g	69.d	69.b			69.a		71.n	

PELICAN LAKE

CATALOGUE NUMBER:	30324	30717	43737	45803	46158
AREA:	2	2	2	2	12
UNIT:	24	24	34	38	8
QUADRANT; SUBQUAD:	2,3	4,2	4,3	1,4	3
LEVEL:	1	1	1	1	3
SUBFILE; CLASS:	1,5	1,5	1,5	1,5	1,5
RAW MATERIAL:	1	18	12	7	2
SOURCE/VARIETY:	1		3		
WEIGHT:	1.1	.9	1.8	.4	.8
MAXIMUM LENGTH:	15.0	20.0	24.1	7.3	12.4
MAXIMUM WIDTH:	16.2	14.5	16.8	15.0	17.0
POS. MAX. WIDTH:	9.1	7.2			
MAXIMUM THICKNESS:	4.6	3.4	4.3	3.0	3.4
POS. MAX. THICKNESS:		12.2	11.4		
BLADE LENGTH:		13.5	17.0		
STEM LENGTH:	6.6	6.5	7.1		6.0
BLADE WIDTH:	16.2	14.5			
SHOULDER WIDTH:	16.0	14.2			
POS. SHOULDER WIDTH:	8.7	6.8			
NECK WIDTH:	12.2	9.7	11.3	10.7	11.0
POS. NECK:	6.8	4.8	5.0	5.5	4.5
STEM WIDTH:	15.9	13.3	12.7	14.8	13.5
BASE WIDTH:	15.6	12.8	11.3	14.2	11.2
BASAL NOTCH DEPTH:					
NOTCH 1 DEPTH:	2.1	1.6			
NOTCH 1 BREADTH:	6.3	5.5	4.2	5.9	
NOTCH 2 DEPTH:		2.3	1.0		3.2
NOTCH 2 BREADTH:	5.5	5.6	4.5		5.2
PROX.-LAT. EDGE 1 HT.:					
PROX.-LAT. EDGE 2 HT.:					
TIP ANGLE:		75			
BLADE ANGLE:					
EDGE 1 ANGLE:			50		
EDGE 2 ANGLE:		45	45		
INTEGRITY:	3	1	1	4	4
LONG. X SEC.:	5	1	1		
TRANS. X SEC.:		1	4		
BLANK TYPE:		1			
BLANK ORIENTATION:		1			
FLAKING TYPE OBVERSE:			8		
FLAKING PATTERN OBVERSE:			8		
FLAKING TYPE REVERSE:		7	8		
FLAKING PATTERN REVERSE:		4	8		
BLADE EDGE 1 SHAPE:					
BLADE EDGE 1 MORPHOLOGY:			2		
BLADE EDGE 2 SHAPE:		1	9		
BLADE EDGE 2 MORPHOLOGY:		2	8		
SHOULDER 1 SHAPE:	3				
SHOULDER 2 SHAPE:		3	3		5
EDGE GRINDING:	2	1	2	2	1
BASE SHAPE:	2	1	1	2	1
BASAL THINNING:	3	3	7	6	3
NOTCH 1 SHAPE:	4	4			
NOTCH 1 ORIENTATION:	3	3	3	3	
NOTCH 2 SHAPE:		4	6		4
NOTCH 2 ORIENTATION:	3	3	3	3	3
NOTCHING TECHNIQUE:	5	4	4	3	3
PROX.-LAT. EDGE 1:	5	5	4	5	
PROX.-LAT. EDGE 2:	5	5	6	5	5
TIP MORPHOLOGY:	7	2	3		
WEAR TYPE:			1		
WEAR LOCATION:			2		
HEAT TREATMENT:					
FIGURE REFERENCE:	70.j	70.a	70.h	69.1	70.i

CONCAVE BASE

CATALOGUE NUMBER:	39512	45500	45806	47251
AREA:	2	2	2	2
UNIT:	30	37	38	22
QUADRANT; SUBQUAD:	3,3	2,1	1,4	2
LEVEL:	2	2	2	
SUBFILE; CLASS:	1,5	1,5	1,5	1,5
RAW MATERIAL:	1	10	1	3
SOURCE/VARIETY:	1			
WEIGHT:	.5	.6	.6	1.4
MAXIMUM LENGTH:	10.5	11.3	16.4	18.2
MAXIMUM WIDTH:	11.9	13.1	13.3	18.7
POS. MAX. WIDTH:		2.5	6.0	6.4
MAXIMUM THICKNESS:	3.3	3.5	2.7	3.6
POS. MAX. THICKNESS:		8.7		8.7
BLADE LENGTH:				
STEM LENGTH:				
BLADE WIDTH:				
SHOULDER WIDTH:				
POS. SHOULDER WIDTH:				
NECK WIDTH:				
POS. NECK:				
STEM WIDTH:				
BASE WIDTH:				
BASAL NOTCH DEPTH:	.8	.9		2.2
NOTCH 1 DEPTH:				
NOTCH 1 BREADTH:				
NOTCH 2 DEPTH:				
NOTCH 2 BREADTH:				
PROX.-LAT. EDGE 1 HT.:				
PROX.-LAT. EDGE 2 HT.:				
TIP ANGLE:				
BLADE ANGLE:				
EDGE 1 ANGLE:			35	35
EDGE 2 ANGLE:		60	35	35
INTEGRITY:	4	2	9	3
LONG. X SEC.:	1	4	1	2
TRANS. X SEC.:			2	3
BLANK TYPE:				
BLANK ORIENTATION:				
FLAKING TYPE OBVERSE:		5	7	8
FLAKING PATTERN OBVERSE:		8	3	8
FLAKING TYPE REVERSE:		5	5	8
FLAKING PATTERN REVERSE:		8	4	8
BLADE EDGE 1 SHAPE:				
BLADE EDGE 1 MORPHOLOGY:			2	1
BLADE EDGE 2 SHAPE:		2		
BLADE EDGE 2 MORPHOLOGY:		1	2	4
SHOULDER 1 SHAPE:				
SHOULDER 2 SHAPE:				
EDGE GRINDING:				
BASE SHAPE:	3	3	3	3
BASAL THINNING:	3	3	3	7
NOTCH 1 SHAPE:				
NOTCH 1 ORIENTATION:				
NOTCH 2 SHAPE:				
NOTCH 2 ORIENTATION:				
NOTCHING TECHNIQUE:				
PROX.-LAT. EDGE 1:				
PROX.-LAT. EDGE 2:				
TIP MORPHOLOGY:	5	8	4	5
WEAR TYPE:				
WEAR LOCATION:				
HEAT TREATMENT:				
FIGURE REFERENCE:		70.1	70.b	70.k

	SMALL STEMMED		NARROW OVATE	
CATALOGUE NUMBER:	33093	44274	41154	46063
AREA:	2	2	2	12
UNIT:	26	35	31	5
QUADRANT; SUBQUAD:	4	2,4	3,4	4
LEVEL:	2	1	1	4
SUBFILE; CLASS:	1,3	1,5	1,5	1,5
RAW MATERIAL:	2	5	1	12
SOURCE/VARIETY:	1		1	2
WEIGHT:	.2	.2	2.1	2.6
MAXIMUM LENGTH:	13.6	12.5	28.9	31.8
MAXIMUM WIDTH:	7.4	6.6	11.9	14.5
POS. MAX. WIDTH:	7.3	6.5	8.7	8.7
MAXIMUM THICKNESS:	1.8	2.4	5.5	5.0
POS. MAX. THICKNESS:	7.3	2.8	7.8	8.8
BLADE LENGTH:	6.2	7.1		27.2
STEM LENGTH:	7.4	5.4		4.6
BLADE WIDTH:	7.4	6.7		14.5
SHOULDER WIDTH:	7.4	6.6		13.9
POS. SHOULDER WIDTH:	5.9	5.8		7.7
NECK WIDTH:	6.7	5.9		9.8
POS. NECK:	5.7	4.4		2.7
STEM WIDTH:	7.4	6.2		10.0
BASE WIDTH:	6.1	6.2		8.9
BASAL NOTCH DEPTH:				
NOTCH 1 DEPTH:	.2			
NOTCH 1 BREADTH:	2.8			
NOTCH 2 DEPTH:	.4			
NOTCH 2 BREADTH:	2.1			
PROX.-LAT. EDGE 1 HT.:				
PROX.-LAT. EDGE 2 HT.:				
TIP ANGLE:	60	60	55	70
BLADE ANGLE:				
EDGE 1 ANGLE:		60	70	70
EDGE 2 ANGLE:		55	70	60
INTEGRITY:	1	1	1	1
LONG. X SEC.:	1	1	8	1
TRANS. X SEC.:	4	1	1	3
BLANK TYPE:	2			
BLANK ORIENTATION:	0			
FLAKING TYPE OBVERSE:	6	8	8	5
FLAKING PATTERN OBVERSE:	8	8	8	2
FLAKING TYPE REVERSE:	6	8	8	5
FLAKING PATTERN REVERSE:	3	8	8	4
BLADE EDGE 1 SHAPE:	1	1	2	5
BLADE EDGE 1 MORPHOLOGY:	5	1	8	2
BLADE EDGE 2 SHAPE:	1	1	2	5
BLADE EDGE 2 MORPHOLOGY:	5	1	2	2
SHOULDER 1 SHAPE:	0			3
SHOULDER 2 SHAPE:	3			4
EDGE GRINDING:			1	1
BASE SHAPE:		2	1	1
BASAL THINNING:		3	1	7
NOTCH 1 SHAPE:				
NOTCH 1 ORIENTATION:				
NOTCH 2 SHAPE:	4			
NOTCH 2 ORIENTATION:	1			
NOTCHING TECHNIQUE:	5			
PROX.-LAT. EDGE 1:	9			
PROX.-LAT. EDGE 2:	9			
TIP MORPHOLOGY:	1	1	3	1
WEAR TYPE:				
WEAR LOCATION:				
HEAT TREATMENT:				
FIGURE REFERENCE:	71.b	68.f	70.g	69.m

NON-CLASSIFIED ATLATL

CATALOGUE NUMBER:	30849	30722	34628	34629	40882	43351	44808	45758
AREA:	2	2	2	2	2	2	2	2
UNIT:	25	24	27	27	31	34	36	38
QUADRANT; SUBQUAD:	1,1	4,3	4,2	4,2	3,2	2,3	1,4	1,3
LEVEL:	1	1	1	1	2	1	1	1
SUBFILE; CLASS:	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5
RAW MATERIAL:	2	1	1	1	1	16	6	7
SOURCE/VARIETY:	1							
WEIGHT:	06	1.9	.6	1.1	.8	2.4	1.6	.7
MAXIMUM LENGTH:	8.9	18.0	9.4		11.9	19.5	17.0	9.3
MAXIMUM WIDTH:	16.9	21.3	16.0		17.9	22.8	15.7	15.9
POS. MAX. WIDTH:						9.0	3.2	
MAXIMUM THICKNESS:	4.2	4.8	3.3		3.5	4.9	4.8	4.5
POS. MAX. THICKNESS:							6.7	
BLADE LENGTH:		14.5						
STEM LENGTH:				7.3	8.3	7.6		
BLADE WIDTH:				11.5		22.8		
SHOULDER WIDTH:				11.2		22.3		
POS. SHOULDER WIDTH:				7.2		7.6		
NECK WIDTH:			12.4	13.6	14.0	15.6		
POS. NECK:			9.4	5.3	6.5	4.3		
STEM WIDTH:	16.9		16.0	6.8	15.9	16.8		15.9
BASE WIDTH:	15.8		12.7	14.8	14.1	15.8		14.8
BASAL NOTCH DEPTH:						.5		
NOTCH 1 DEPTH:				1.4	1.6	1.9		
NOTCH 1 BREADTH:				3.7	6.2	5.8		
NOTCH 2 DEPTH:		1.7			1.5	1.3	.7	
NOTCH 2 BREADTH:		3.9		3.3	5.0	6.0	2.9	
PROX.-LAT. EDGE 1 HT.:	2.6			2.3	3.3	2.4		2.3
PROX.-LAT. EDGE 2 HT.:	3.0		4.6		1.8	1.9		2.6
TIP ANGLE:		110						
BLADE ANGLE:								
EDGE 1 ANGLE:		45				55	45	
EDGE 2 ANGLE:		50				55	50	
INTEGRITY:	4	5	4	9	4	3	2	4
LONG. X SEC.:		1		3		1	5	
TRANS. X SEC.:								
BLANK TYPE:								
BLANK ORIENTATION:								
FLAKING TYPE OBVERSE:		5				5	8	
FLAKING PATTERN OBVERSE:		8				8	8	
FLAKING TYPE REVERSE:		5				5	8	
FLAKING PATTERN REVERSE:		3				2	8	
BLADE EDGE 1 SHAPE:		4						
BLADE EDGE 1 MORPHOLOGY:		1						
BLADE EDGE 2 SHAPE:		1						
BLADE EDGE 2 MORPHOLOGY:		1						
SHOULDER 1 SHAPE:				4		4	9	
SHOULDER 2 SHAPE:		3		4		4	4	
EDGE GRINDING:			1	9		2	1	1
BASE SHAPE:	2		1	1	1	3	1	1
BASAL THINNING:	1		3	4	6	6	1	
NOTCH 1 SHAPE:	3			5	6	4	9	
NOTCH 1 ORIENTATION:				1	3	3	9	
NOTCH 2 SHAPE:		4		7	6	4	4	
NOTCH 2 ORIENTATION:		1		1	3	3	1	
NOTCHING TECHNIQUE:	4		3	3	4	3	8	3
PROX.-LAT. EDGE 1:	1		1	8	6	6		6
PROX.-LAT. EDGE 2:	1	6	3		6	6	9	6
TIP MORPHOLOGY:		3		5	4	8	5	
WEAR TYPE:		0						
WEAR LOCATION:		0						
HEAT TREATMENT:	3				3	7		
FIGURE REFERENCE:	69.j	69.o	72.e	69.q	70.c	69.n		69.k

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